University of Pennsylvania

The Wharton School

Accounting 102

Professor Rajan: Fall 1997

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WHARTON REPROGRAPHICS

MANAGING

ACCOUNTING BORES YOU? WAKE UP

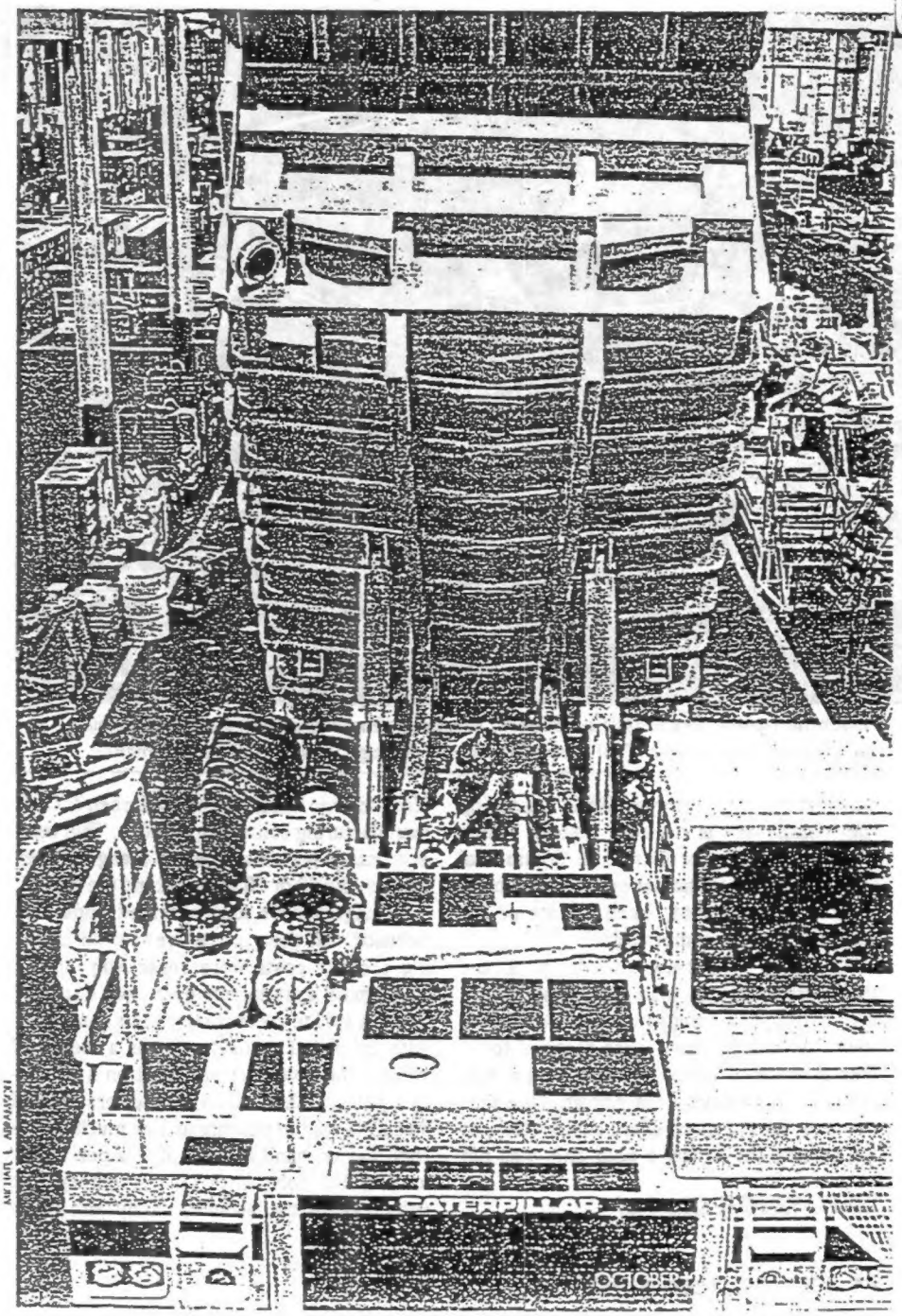
Most companies are working with flawed estimates of what it costs to make their products. Smart managers are finally getting the numbers right. Here's how.

■ *by Ford S. Worthy*

A LARGE, highly regarded consumer goods manufacturer offers more than a dozen versions of one of its leading products. The numbers cranked out by the company's accounting system suggest that each version costs about the same to produce. Because the products are priced similarly, they apparently earn equivalent profit margins. But the company's top manufacturing executive knows otherwise. His gut tells him that some low-volume products are money losers. Says he: "We've been hiding the real picture from ourselves."

Another big diversified company used to be in the business of rebuilding locomotives. The managers of the division that included the locomotive operation thought they were making money until a consulting firm figured out that costs had been seriously underestimated. The company bailed out of the business, and not a moment too soon. Says Dale Marco, the consultant who advised the company: "The more contracts it won, the more money it lost."

These two companies and hundreds of others suffer from the same insidious problem: The methods they use to allocate costs among their many products are hopelessly obsolete. As a result, companies are pricing some products too high and others too low. They are making some products they ought not to be selling at all and are buying others, often from overseas suppliers, that they could more profitably make themselves. "Many U.S. companies don't know where they are making money and where they are losing," says Robert S. Kaplan, a Harvard accounting professor who is one of the harshest critics of prevailing cost systems. The blurred numbers also lead companies to mis-



ANTHONY J. ARMSTRONG

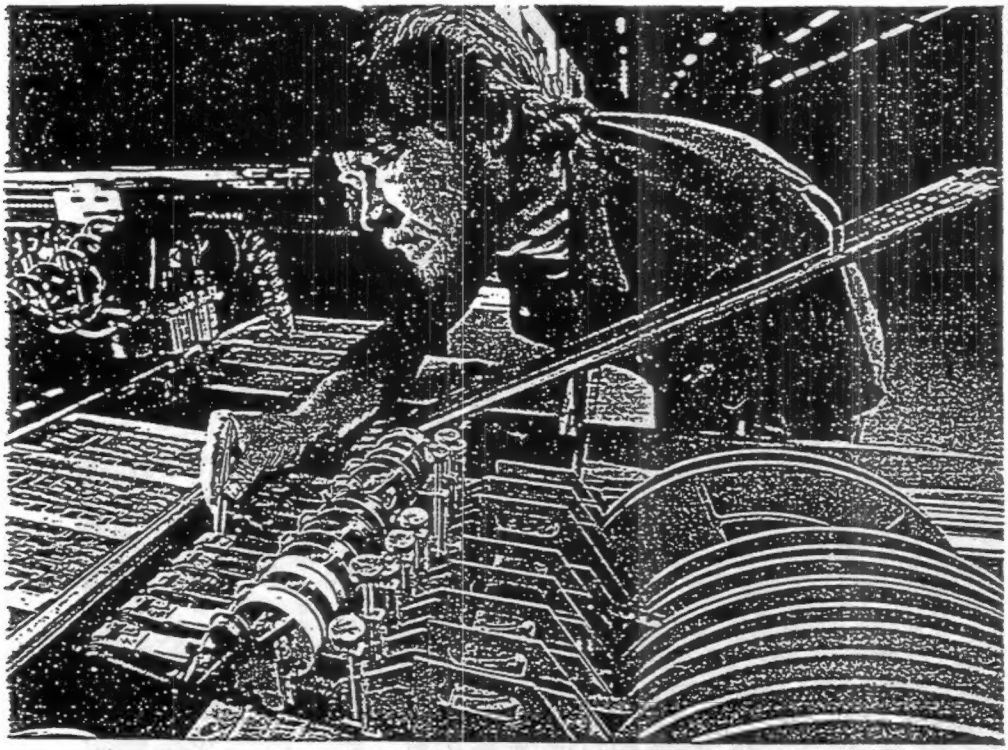
Caterpillar *allocates overhead directly to individual products, such as this off-highway truck, instead of spreading it around like peanut butter the way other companies do.*

allocate capital, and stymie efforts by plant managers to improve efficiency.

How could the crew in the green eyeshades have allowed the numbers to run amok? And what about the shop floor supervisors and corporate executives managing the business? Are their goggles opaque too? "People have simply not been paying attention to cost accounting," answers Bob Kaplan. "It's a boring subject. A manager would rather devise new products and new sales strategies. He hasn't wanted to hear that his cost system was broken." Even when the message has been delivered, few managers consider it a high priority. While conceding the weaknesses in his cost system, James Lewis, who heads a division of Continental Can, asks: "Does it hinder our ability to compete? Probably not, because we're no dumber than our competition."

That is a dangerous attitude given the threat from foreign manufacturers. Before the 1970s, U.S. companies so dominated their markets that they were destined to do well in spite of faulty cost-accounting systems. In those days, says Kaplan, "the premium for having an excellent cost system, or the penalty for having a poor one, was not very high."

REPORTER ASSOCIATE *Leslie Brody*



BILL BAUDEORG

Machine operators *at IBM's Lexington, Kentucky, plant do their own maintenance and quality-control inspections. That allows the company to assign those costs directly to products.*

Just when the competition was getting tougher, the deficiencies in cost systems increased. Over the past two decades most corporations have thoroughly revamped their manufacturing processes, notably by replacing people with machines. Yet the typical accounting system still focuses on labor costs, so the magnitude of the errors in cost estimates has gotten worse. Companies also are pouring huge sums into research and development, and they offer customers not just model A of a product, but variations B through Z. Each of these changes has fundamentally altered the costs of manufacturing, says Steve Hronec, who heads Arthur Andersen & Co.'s manufacturing consulting practice. "But cost-accounting systems have not changed. They are literally 60 or 70 years behind the times."

Managers have long operated under the delusion that their procedures for determining product costs were reasonably sound. The typical system, however, was designed not as a tool to measure the costs associated with individual products, but as a means of valuing the inventory reported on a company's balance sheet. Outside auditors needed a reliable way to determine how much inventory was on hand at the end of a period. As long as the company's *total* inventory was valued correctly, auditors rarely lost sleep over the possibility that the pile of semiconductor chips over in the corner might have been overvalued, while the stack of typewriters was undervalued.

In valuing inventories, accountants include three types of costs: materials, overhead, and the labor that goes directly into making products. Allocating materials and labor costs to specific products is fairly straightforward. But accountants have big trouble dealing with overhead, a black hole that swallows up everything from the equipment used to fashion a product to the security guard who watches over the plant at night. How much of the purchasing agent's salary is attributable to the semiconductor chip, how much to the typewriter, how much to the hundred other products made in the same plant? What about the grease that keeps the machines humming, or the computers that make sure paychecks come out on time? Boiled down to its simplest form, the question becomes: Which products cause which costs?

WHILE COMPANIES use many different schemes to allocate overhead, the most common goes something like this. First, managers spread common costs like purchasing, maintenance, and rent among a plant's major production departments. The departments include such areas as fabrication, assembly, and packaging. Many companies perform this step reasonably well. Purchasing costs, for example, might be allocated according to the number of purchase orders filled on behalf of each department.

Next, the costs in each department are assigned to the individual products that pass through it. That is where most accounting systems break down. In this step, the allocation of costs usually is based on just one factor, commonly the proportion of the production department's direct labor hours that go into making each product.

Allocating overhead on the basis of direct labor hours was passable when plants made just a handful of products and labor was the biggest expense. But today some plants turn out thousands of products that require vastly different production processes. As companies have replaced people with machinery, overhead—which includes depreciation of the equipment—has soared. At many companies it now accounts for half of total production costs. Direct labor, which frequently accounted for 40% of production costs 25 years ago, often represents no more than 5% today.

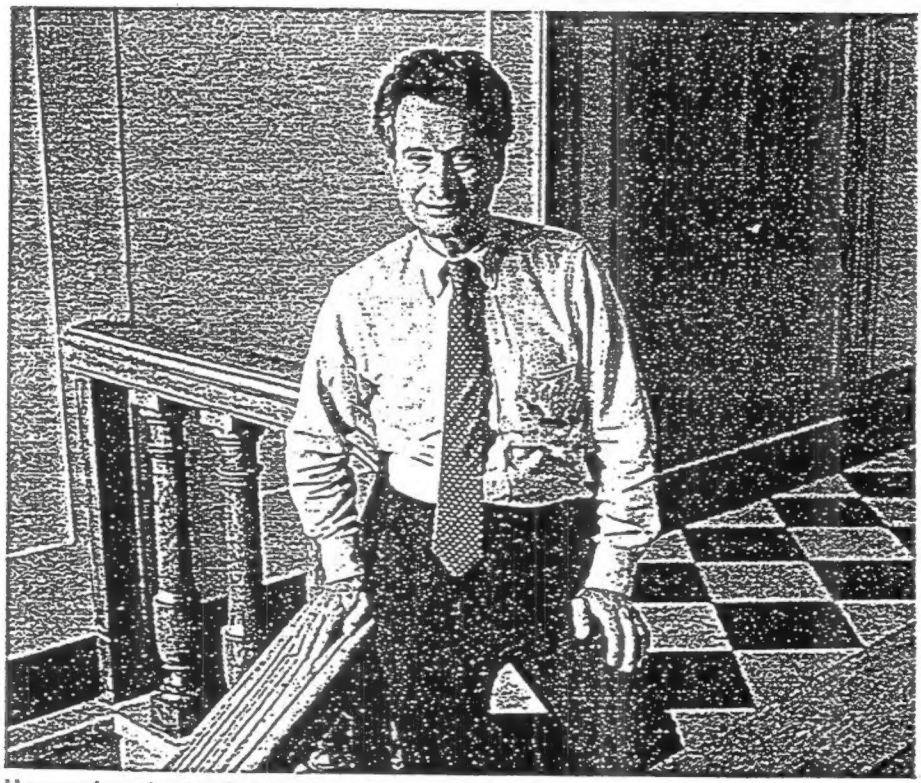
Consider what goes on every day at a Con-

tinental Can factory in West Chicago. The plant produces thousands of parts for can-making machines, including the small, doughnut-shaped components that help attach lids to beer cans. Some versions of these so-called seaming rolls are high-volume parts the company has been making for 20 years. The operators who run the drill presses and lathes have the older models down to a science. It shows. The most popular seaming rolls generate little scrap and rarely need any reworking after they are completed. In contrast, before a brand-new model can be made, designers must encode specifications onto computer tapes that control the sophisticated (and expensive-to-maintain) machine tools used to fabricate the part.

AS IT HAPPENS, all seaming rolls require the same amount of labor and have roughly the same material costs. You know which ones ought to have the higher cost (the new models), and so does Jim Lewis, whose division turns them out. But the plant's cost system, which allocates overhead on the basis of direct labor hours, says that the costs of making the older, high-volume models and the newer, low-volume ones are the same. Says Lewis: "We have to find a way to better identify our costs."

This perverse way of assigning costs can make high-volume products look much more expensive than they really are. In one case, Rockwell International realized that its line of heavy-duty truck axles was selling erratically. One of its best-selling axles had begun losing market share. To find out why, the division managers conducted a special study. They found that the practice of essentially allocating overhead in proportion to direct labor costs had created serious distortions. Jack Schubert, corporate cost-accounting director for Rockwell, says the division had been "overcosting" its highest-volume axle by roughly 20%, while underestimating the cost of other axles by as much as 40%. Because the company had priced its products in relation to their estimated costs, it had been overpricing the high-volume product. That lured competitors into the market. "Competitors don't want your cats and dogs," says Schubert, who is redesigning Rockwell's cost systems. "They want the volume business."

The imaginary profits—and losses—that arise from flawed cost systems can lead to very expensive blunders. Consultant Robert A. Howell says he knows of many companies that have given up high-volume—but apparently low-margin—products to foreign competitors, leaving themselves with low-volume products whose true costs are actually much higher than thought. Says Howell, who teaches accounting at New York University: "We may be giving away the best business to foreign companies."



Harvard professor Robert Kaplan *argues that archaic cost-accounting systems that allocate overhead according to formulas yield product "costs" that are off by as much as 200%.*

SUCH MISTAKES are compounded by a cruel irony: Once the high-volume products disappear, those that remain must carry a greater share of overhead and thus become even less profitable. Says Robert McIlhattan, a partner in Ernst & Whinney's Chicago office: "I've had clients that have dropped whole product lines. Then the products they kept couldn't support the remaining costs, so they dropped them too."

Misallocation of overhead is only one of the flaws in cost accounting. Even in this era of just-in-time inventories, many companies ignore the cost of carrying inventories when evaluating the profitability of individual products. If a product routinely accounts for the lion's share of total inventories, it ought to be charged with both the costs of financing the inventory and the costs of such things as extra storage space and record keeping. Robert Howell recalls a food-processing company that churned out so much inventory it had to lease container cars on a rail siding just to hold the stuff. The seemingly profitable product was a loser if the costs associated with the excess inventory were charged against it.

Many systems focus almost exclusively on the costs incurred within the walls of the plant, ignoring up-front outlays for research and development and postproduction expenses for distribution and marketing. According to Harvard professor Robin Cooper, these nonproduction expenses can easily make up 25% of the cost of some products and less than 10% for others. Managers may know intuitively that one product is really cheaper and another more expensive than the reports tell them. "They know the direction of the bias," says Harvard's Kaplan. "But I don't think their intuition gives them any notion of what the magnitude can be. The distortions can be very large—50%, 100%, even 200%."

Costs also can vary considerably from customer to customer. Some buyers create headaches for the producer by insisting that they be served first or by paying late. Others are more costly to serve simply because they are so far from the plant. Like many companies, Campbell Soup has always charged all customers the same prices, although it costs far more to ship soup to Alas-

ka than to grocery stores in Philadelphia, a short hop from the company's original kitchen. But how much more? Campbell doesn't know, and some of its executives are pushing for accounting changes that would provide the answer.

Companies that do not understand their costs are apt to misallocate capital. Managers say they don't rely solely on the figures produced by their regular cost system when making large investments. But most companies do use the routine numbers to make the first cut of investment opportunities that merit more study. Says Lee Steele, a cost-accounting expert at Touche Ross: "Suppose you think you're making an 8% margin on a product. Even though you could probably gain market share if you added capacity, you probably won't invest in that area because of the low margin. But what if your margin is really 15%?" Steele is now working with a large electronics company whose fuzzy cost system, he believes, has obscured countless investment opportunities.

Managers also use this flawed cost-tracking apparatus as a tool to manage the day-to-day operations on the shop floor. Yet the most readily available cost information often is expressed in too little detail. Suppose a product engineer introduces a big change in the way a product is made. As Mark Coran, vice president of finance for Pratt & Whitney, puts it: "Analytically, you know your costs should change. But if they are spread around among many products according to a formula, you can't see the impact of what you did. So you can't tell whether you accomplished anything or not."

IN THE FACE OF so many maddening problems, a small but growing number of companies are retooling their cost-accounting systems. Some 30 manufacturers, including Rockwell, Eastman Kodak, and General Electric, are part of an organization called Computer Aided Manufacturing International, which has been at work for two years developing a conceptual framework to update cost management systems. Because each company is different, there is no single cookbook solution to the problem. But some general principles make sense for all companies.

First, don't scrap the existing cost system. Since it probably does a good job determining inventory costs, let it continue to perform that role.

Second, the new cost management system doesn't need to be precise to the penny. Mike Gearhardt, an assistant controller at Day International, an industrial plastics company, says he knows accountants who boast of calculating the cost of $10 products down to the fourth decimal place. What they really ought to worry about is whether the product costs $10 or $6.

Finally, think of costs in terms of the products and customers that cause them. Three years ago IBM set up what it calls a corporate cost competency center, a group that encourages operating divisions to charge overhead costs directly to specific products rather than spreading them around like peanut butter. At many IBM facilities, the company's "cost competency" has benefited from new plant layouts in which equipment is arranged in discrete units dedicated to making a group of similar products. At its Lexington, Kentucky, plant, for example, typewriters and computer

keyboards move not from one common functional department (fabrication, say) to another (assembly), but flow through their own tightly arranged production lines.

These production lines should be as self-contained as practical. At some IBM plants, the workers on the lines are even responsible for doing their own maintenance, quality control, and other jobs that were formerly handled by central departments serving the whole plant. While the new layouts were motivated by the company's desire to speed the production cycle and reduce work-in-process inventory, the arrangement gives accountants a clearer picture of which costs are associated with which products. Robert Kelder, IBM's cost competency program manager, says that in the past a typical plant had to allocate about 75% of its overhead according to an arbitrary formula, leading to significant distortions in the estimated costs of some products. In the plants that have made the change to direct charging, only 25% of overhead has to be allocated; the rest is clearly identified with specific products.

Caterpillar, whose immense plants are laid out more traditionally, takes a different approach. Rather than homogenizing the costs generated by its many fabrication departments, it regards each major piece of production machinery as an individual cost center. Each machine is like a small bucket that contains its share of overhead costs. At Caterpillar's heavy-equipment plant in Decatur, Illinois, the company breaks down costs into more than 1,300 overhead buckets. A machine that takes up a lot of floor space is allocated a larger proportion of rent than a smaller machine. If the smaller machine is harder to maintain or uses a lot of electricity, it gets proportionately more of those costs. In most cases, Caterpillar assigns these buckets of overhead costs to specific products according to how much time each one spends passing through each machine. Says Lou Jones, controller at the Decatur plant: "We have the ability to look at our costs all the way from the total product cost down to an individual part within that product, and then down to an individual operation within that part."

Zenith is another stickler for matching production costs with products. The last surviving U.S.–owned producer of television sets also pays close attention to nonproduction expenses and includes them in its calculations of product costs. For instance, the company is more rigorous than most in breaking down its sales and marketing outlays on a product-by-product basis, so that it has an unusually close fix on its true profit margins.

MOST LARGE COMPANIES seem to recognize that their cost systems are not responsive to today's competitive environment. "We have their awareness and we've overcome denial," says Kaplan. But few companies have seized the opportunity that awaits those that modernize their accounting practices. Quite simply, accurate cost information can give a company a competitive advantage. Steve Hronec of Arthur Andersen says one of his clients is overhauling its cost system for precisely that reason. "Their goal is to blow away the competition," says Hronec. "They don't have any foreign competitors in the U.S., and they plan to keep it that way." ■

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WHARTON REPROGRAPHICS

Use activity-based costing to guide corporate strategy.

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Measure Costs Right: Make the Right Decisions

by Robin Cooper and Robert S. Kaplan

Managers in companies selling multiple products are making important decisions about pricing, product mix, and process technology based on distorted cost information. What's worse, alternative information rarely exists to alert these managers that product costs are badly flawed. Most companies detect the problem only after their competitiveness and profitability have deteriorated.

Distorted cost information is the result of sensible accounting choices made decades ago, when most companies manufactured a narrow range of products. Back then, the costs of direct labor and materials, the most important production factors, could be traced easily to individual products. Distortions from allocating factory and corporate overhead by burden rates on direct labor were minor. And the expense of collecting and processing data made it hard to justify more sophisticated allocation of these and other indirect costs.

Today, product lines and marketing channels have proliferated. Direct labor now represents a small fraction of corporate costs, while expenses covering factory support operations, marketing, distribution, engineering, and other overhead functions have exploded. But most companies still allocate these rising overhead and support costs by their diminishing direct labor base or, as with marketing and distribution costs, not at all.

These simplistic approaches are no longer justifiable – especially given the plummeting costs of information technology. They can also be dangerous. Intensified global competition and radically new production technologies have made accurate product cost information crucial to competitive success.

Bad information on product costs leads to bad competitive strategy.

We have written extensively on the shortcomings of typical cost accounting systems.[1] In this article we present an alternative approach, which we refer to as activity-based costing. The theory behind our method is simple. Virtually all of a company's activities exist to support the production and delivery of today's goods and services. They should therefore all be considered product costs. And since nearly all fac-

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tory and corporate support costs are divisible or separable, they can be split apart and traced to individual products or product families. These costs include:

Logistics
Production
Marketing and Sales
Distribution
Service
Technology
Financial Administration
Information Resources
General Administration

Conventional economics and management accounting treat costs as variable only if they change with short-term fluctuations in output. We (and others) have found that many important cost categories vary not with short-term changes in output but with changes over a period of years in the design, mix, and range of a company's products and customers. An effective system to measure product costs must identify and assign to products these costs of complexity.

Many managers understand intuitively that their accounting systems distort product costs, so they make informal adjustments to compensate. But few can predict the magnitude and impact of the adjustments they should be making.

Consider the experience of a leading manufacturer of hydraulic valves whose product line included thousands of items. About 20% of the valves generated 80% of total revenues, a typical ratio for multiproduct organizations. Of even greater interest, 60% of the products generated 99% of the revenues. Nonetheless, management remained enthusiastic about the 40% of its products that generated only 1% of revenues. According to its cost system, these specialty items had the best gross margins.

An analysis using activity-based costing told a very different story. More than 75% of this company's products (mostly the low-volume items) were *losing* money. The products that did make money (fewer than one in four) generated more than 80% of sales and 300% of net profits.

Top executives may be understandably reluctant to abandon existing product cost systems in favor of a new approach that reflects a radically different philosophy. We do not advocate such an abrupt overhaul. The availability of cheap, powerful personal computers, spread sheets, and data-base languages allows businesses to develop new cost systems for strategic purposes off-line from official accounting systems. Companies don't have to commit their entire accounting system to activity-based costing to use it.

Indeed, activity-based costing is as much a tool of corporate strategy as it is a formal accounting system. Decisions about pricing, marketing, product design, and mix are among the most important ones managers make. None of them can be made effectively without accurate knowledge of product costs.

What Distorts Cost Data?

Product cost distortions occur in virtually all organizations producing and selling multiple products or services. To understand why, consider two hypothetical plants turning out a simple product, ballpoint pens. The factories are the same size and have the same capital equipment. Every year Plant I makes one million blue pens. Plant II also produces blue pens, but only 100,000 per year. To fill the plant, keep the work force busy, and absorb fixed costs, Plant II also produces a variety of similar products: 60,000 black pens, 12,000 red pens, 10,000 lavender pens, and so on. In a typical year, Plant II produces up to 1,000 product variations with volumes ranging between 500 and 100,000 units. Its aggregate annual output equals the one million units of Plant I, and it requires the same total standard direct labor hours, machine hours, and direct material.

Despite the similarities in product and total output, a visitor walking through the two plants would notice dramatic differences. Plant II would have a much larger production support staff—more people to schedule machines, perform setups, inspect items after setup, receive and inspect incoming materials and parts, move inventory, assemble and ship orders, expedite orders, rework defective items, design and implement engineering change orders, negotiate with vendors, schedule materials and parts receipts, and update and program the much larger computer-based information system. Plant II would also operate with considerably higher levels of idle time, overtime, inventory, rework, and scrap.

Plant II's extensive factory support resources and production inefficiencies generate cost-system distortions. Most companies allocate factory support costs in a two-step process. First, they collect the costs into categories that correspond to responsibility centers (production control, quality assurance, receiving) and assign these costs to operating departments. Many companies do this first step very well.

But the second step—tracing costs from the operating departments to specific products—is done sim-

1. See H. Thomas Johnson and Robert S. Kaplan, *Relevance Lost: The Rise and Fall of Management Accounting* (Boston: Harvard Business School Press, 1987) and Robin Cooper and Robert S. Kaplan, "How Cost Accounting Distorts Product Costs," *Management Accounting*, April 1988, p. 20.

plistically. Many companies still use direct labor hours as an allocation base. Others, recognizing the declining role of direct labor, use two additional allocation bases. Materials-related expenses (costs to purchase, receive, inspect, and store materials) are allocated directly to products as a percentage markup over direct materials costs. And machine hours, or processing time, are used to allocate production costs in highly automated environments.

Whether Plant II uses one or all of these approaches, its cost system invariably—and mistakenly—reports production costs for the high-volume product (blue pens) that greatly exceed the costs for the same product built in Plant I. One does not need to know much about the cost system or the production process in Plant II to predict that blue pens, which represent 10% of output, will have about 10% of the factory costs allocated to them. Similarly, lavender pens, which represent 1% of Plant II's output, will have about 1% of the factory's costs allocated to them. In fact, if the standard output per unit of direct labor hours, machine hours, and materials quantities are the same for blue pens as for lavender pens, the two types of pens will have *identical* reported costs

> Existing cost systems frequently understate profits on high-volume products and overstate profits on specialty items.

—even though lavender pens, which are ordered, fabricated, packaged, and shipped in much lower volumes, consume far more overhead per unit.

Think of the strategic consequences. Over time, the market price for blue pens, as for most high-volume products, will be determined by focused and efficient producers like Plant I. Managers of Plant II will notice that their profit margin on blue pens is lower than on their specialty products. The price for blue pens is lower than for lavender pens, but the cost system reports that blue pens are as expensive to make as the lavender.

While disappointed with the low margins on blue pens, Plant II's managers are pleased they're a full-line producer. Customers are willing to pay premiums for specialty products like lavender pens, which are apparently no more expensive to make than commodity-type blue pens. The logical strategic response? De-emphasize blue pens and offer an expanded line of differentiated products with unique features and options.

In reality, of course, this strategy will be disastrous. Blue pens in Plant II are cheaper to make than lavender pens—no matter what the cost system reports. Scaling back on blue pens and replacing the lost output by adding new models will further increase overhead. Plant II's managers will simmer with frustration as total costs rise and profitability goals remain elusive. An activity-based cost system would not generate distorted information and misguided strategic signals of this sort.

Designing an Activity-Based Cost System

The first step in designing a new product cost system is to collect accurate data on direct labor and materials costs. Next, examine the demands made by particular products on indirect resources. Three rules should guide this process:

1. Focus on expensive resources.
2. Emphasize resources whose consumption varies significantly by product and product type; look for diversity.
3. Focus on resources whose demand patterns are uncorrelated with traditional allocation measures like direct labor, processing time, and materials.

Rule 1 leads us to resource categories where the new costing process has the potential to make big differences in product costs. A company that makes industrial goods with a high ratio of factory costs to total costs will want a system that emphasizes tracing manufacturing overhead to products. A consumer goods producer will want to analyze its marketing, distribution, and service costs by product lines, channels, customers, and regions. High-technology companies must study the demands made on engineering, product improvement, and process development resources by their different products and product lines.

Rules 2 and 3 identify resources with the greatest potential for distortion under traditional systems. They point to activities for which the usual surrogates—labor hours, material quantities, or machine hours—do not represent adequate measures of resource consumption. The central question is, which parts of the organization tend to grow as the company increases the diversity of its product line, its processing technologies, its customer base, its marketing channels, its supplier base?

The process of tracing costs, first from resources to activities and then from activities to specific products, cannot be done with surgical precision. We cannot estimate to four significant digits the added

Allocating Costs under an Activity-Based System

The process of designing and implementing an activity-based cost system for support departments usually begins with interviews of the department heads. The interviews yield insights into departmental operations and into the factors that trigger departmental activities. Subsequent analysis traces these activities to specific products.

The following example illustrates the activity-based costing process for an inventory control department responsible for raw materials and purchased components. The annual costs associated with the department (mainly personnel costs) are $500,000.

Interview Department Head

Q: How many people work for you?
A: Twelve.

Q: What do they do?
A: Six of them spend most of their time handling incoming shipments of purchased parts. They handle everything—from documentation to transferring parts to the WIP stockroom. Three others work in raw materials. After the material clears inspection, they move it into inventory and take care of the paperwork.

Q: What determines the time required to process an incoming shipment? Does it matter if the shipment is large or small?
A: Not for parts. They go directly to the WIP stockroom, and unless it's an extremely large shipment it can be handled in one trip. With raw materials, though, volume can play a big role in processing time. But there are only a few large raw material shipments. Over the course of a year, the time required to process a part or raw material really depends on the number of times it's received, not on the size of the shipments in which it comes.

Q: What other factors affect your department's work load?
A: Well, there are three people I haven't discussed yet. They disburse raw material to the shop floor. Again, volume is not really an issue; it's more the number of times material has to be disbursed.

Q: Do you usually disburse the total amount of material required for a production run all at once, or does it go out in smaller quantities?
A: It varies with the size of the run. On a big run we can't disburse it all at once—there would be too much raw material on the shop floor. On smaller runs—and I'd say that's 80% of all runs—we'd send it there in a single trip once setup is complete.

Design the System

After the interview, the system designer can use the number of people involved in each activity to allocate the department's $500,000 cost:

Activity	People	Total Cost
Receiving purchased parts	6	$250,000
Receiving raw material	3	$125,000
Disbursing material	3	$125,000

In 1987, this company received 25,000 shipments of purchased parts and 10,000 shipments of raw materials. The factory made 5,000 production runs. Dividing these totals into the support dollars associated with each activity yields the following costs per unit of activity:

Activity	Allocation Measure	Unit Cost
Receiving purchased parts	Number of shipments per year	$10 per shipment
Receiving raw material	Number of shipments per year	$12.50 per shipment
Disbursing material	Number of production runs	$25 per run

We can now attribute inventory control support costs to specific products. Suppose the company manufactures 1,000 units of Product A in a year. Product A is a complex product with more than 50 purchased parts and several different types of raw material. During the year, the 1,000 units were assembled in 10 different production runs requiring 200 purchased parts shipments and 50 different raw material shipments. Product A incurs $2,875 in inventory control overhead ($10 × 200 + $12.50 × 50 + $25 × 10) to produce the 1,000 units, or $2.88 of inventory control costs per unit.

Product A also consumed 1,000 hours of direct labor out of the factory's total of 400,000 hours. A labor-based allocation system would allocate $1,250 of inventory control costs to the 1,000 units produced ($500,000/400,000 × 1,000) for a per-unit cost of $1.25. The 230% cost difference between the activity-based attribution ($2.88) and the labor-based allocation ($1.25) reflects the fact that the complex, low-volume Product A demands a much greater share of inventory control resources than its share of factory direct-labor hours.

burden on support resources of introducing two new variations of a product. But it is better to be basically correct with activity-based costing, say, within 5% or 10% of the actual demands a product makes on organizational resources, than to be precisely wrong (perhaps by as much as 200%) using outdated allocation techniques.

The insert "Allocating Costs under an Activity-Based System" shows how a company might calculate and assign the support costs of a common manufacturing overhead function—raw materials and parts control. The principles and methods, while illustrated in a conventional manufacturing setting, are applicable to any significant collection of corporate resources in the manufacturing or service sector.

The Impact of Activity-Based Costing

An activity-based system can paint a picture of product costs radically different from data generated by traditional systems. These differences arise because of the system's more sophisticated approach to attributing factory overhead, corporate overhead, and other organizational resources, first to activities and then to the products that create demand for these indirect resources.

Manufacturing Overhead. Let's look more closely at the manufacturer of hydraulic valves mentioned earlier. Cost information on seven representative products is presented in the table "How Activity-Based Costing Changes Product Profitability." Under the old cost system, the overhead charge per unit did not differ much among the seven valves, ranging from $5.34 to $8.88. Under the new system, which traces overhead costs directly to factory support activities and then to products, the range in overhead cost per unit widened dramatically—from $4.39 to $77.64. With four low- to medium-volume products (valves 2 through 5), the overhead cost estimate increased by 100% or more. For the two highest volume products (valves 1 and 6), the overhead cost declined.

The strategic consequences of these data are enormous. Under the labor-based cost system, valve 3 was considered the most profitable product of the seven, with a gross margin of 47%. The activity-based system, in contrast, revealed that when orders for valve 3 arrived, the company would have done better to mail its customers cash to buy the valves elsewhere than to make them itself.

Labor-based cost systems don't always underestimate the overhead demands of low-volume products. Valve 7, with the second lowest volume in the group, shows a marked decrease in overhead under an activity-based system. Why? Valve 7 is assembled from components already being used on the high-volume products (valves 1 and 6). The bulk of any factory's overhead costs are associated with ordering parts, keeping track of them, inspecting them, and setting up to produce components. For parts and components ordered or fabricated in large volumes, the per-unit impact of these transaction costs is modest. Therefore, specialized products assembled from high-volume components will have low production costs even if shipping volume is not high.

Marketing Expenses. The redesign of cost systems should not be limited to factory support costs. Many companies have selling, general, and administrative (SG&A) expenses that exceed 20% of total revenues. Yet they treat these costs as period expenses, not charges to be allocated to products. While such "below the [gross margin] line" treatment may be adequate, even required, for financial accounting, it is poor practice for measuring product costs.

We studied a building supplies company that distributed its products through six channels—two in the consumer market and four in the commercial market. Across all its products, this company had an average gross margin of 34%. Marketing costs for the six channels averaged 16.4% of sales, with general and administrative expenses another 8.5%. (The tables entitled "OEM Changes from a Laggard...to a Solid Performer" present information on the four commercial channels.)

With operating profits in the commercial sector at only about 10% of revenues, the company was looking to improve its profitability. Management decided to focus on SG&A expenses. Previously, the company had allocated SG&A costs by assigning 25% of sales—the company average—to each distribution segment. A more sophisticated analysis, similar in philosophy to the overhead analysis performed by the hydraulic valve company, produced striking changes in product costs.

> Management thought valve 3 was a cash cow. It might as well have mailed checks to its customers.

The OEM business was originally a prime target for elimination. Its 27% gross margin and laggard 2% operating margin put it at the bottom of the pack among commercial channels. But the OEM channel

How Activity-Based Costing Changes Product Profitability*

Valve Number	Annual Volume (units)	Manufacturing Overhead Per Unit			Gross Margin	
		Old System	New System	Percent Difference	Old System	New System
1	43,562	$5.44	$ 4.76	− 12.5%	41%	46%
2	500	6.15	12.86	+109.0	30	− 24
3	53	7.30	77.64	+964.0	47	−258
4	2,079	8.88	19.76	+123.0	26	− 32
5	5,670	7.58	15.17	+100.0	39	2
6	11,196	5.34	5.26	− 1.5	41	41
7	423	5.92	4.39	− 26.0	31	43

*We are not confident that the table's figures are exactly correct. For example, students of this case have estimated the appropriate overhead charge on valve 3 (listed at $77.64 per unit) to be as low as $64 and as high as $84. Whatever the exact figure, the difference between this activity-based cost and the original estimate ($7.30 per unit) suggests that the current labor-based system is seriously flawed.

used virtually no resources in several major selling categories: advertising, catalog, sales promotion, and warranty. In the remaining selling categories, the OEM channel used proportionately fewer resources per sales dollar than the other major channels. Its marketing expenses were 9% of sales, well below the 15% average for the four commercial channels. A sounder estimate of OEM operating margin was 9%, not 2%.

The OEM segment looked even better after the company extended the analysis by allocating invested capital to specific channels. The OEM business required far less investment in working capital—accounts receivable and inventory—than the other commercial channels. Thus, even though the OEM channel had a below-average gross margin, its bottom-line return-on-investment turned out to be higher than the commercial average.

Other Corporate Overhead. Virtually all organizational costs, not just factory overhead or marketing expenses, can and should be traced to the activities for which these resources are used, and then to the divisions, channels, and product lines that consume them. Weyerhaeuser Company recently instituted a charge-back system to trace corporate overhead department costs to the activities that drive them.[2]

For example, Weyerhaeuser's financial services department analyzed all the activities it performed—including data-base administration, general accounting, accounts payable and receivable, and invoicing—to determine what factors create demands for them. A division dealing with a small number of high-volume customers makes very different demands on activities like accounts receivable from a division with many low-volume customers. Before instituting the charge-back system, Weyerhaeuser applied the cost of accounts receivable and other functions as a uniform percentage of a division's sales—a driver that bore little or no relation to the activities that created the administrative work. Now it allocates costs based on which divisions (and product lines) generate the costs.

Similarly, companies engaged in major product development and process improvements should attribute the costs of design and engineering resources to the products and product lines that benefit from them. Otherwise, product and process modification costs will be shifted onto product lines for which little development effort is being performed.

Where Does Activity-Based Costing Stop?

We believe that only two types of costs should be excluded from a system of activity-based costing. First, the costs of excess capacity should not be charged to individual products. To use a simplified example, consider a one-product plant whose practical production capacity is one million units per year. The plant's total annual costs amount to $5 million. At full capacity the cost per unit is $5. This is the unit product cost the company should use regardless of the plant's budgeted production volume. The cost of excess or idle capacity should be treated as a separate line item—a cost of the period, not of individual products.

2. See H. Thomas Johnson and Dennis A. Loewe, "How Weyerhaeuser Manages Corporate Overhead Costs," *Management Accounting*, August 1987, p. 20.

OEM Changes from a Laggard...

Profits by Commercial Distribution Channel (Old System)

	Contract	*Industrial Suppliers*	*Government*	*OEM*	*Total Commercial*
Annual Sales *(in thousands of dollars)*	$79,434	$25,110	$422	$9,200	$114,166
Gross Margin	34%	41%	23%	27%	35%
Gross Profit	$27,375	$10,284	$136	$2,461	$ 40,256
SG&A Allowance* *(in thousands of dollars)*	$19,746	$ 6,242	$105	$2,287	$ 31,814
Operating Profit *(in thousands of dollars)*	$ 7,629	$ 4,042	$ 31	$ 174	$ 11,876
Operating Margin	10%	16%	7%	2%	10%
Invested Capital Allowance† *(in thousands of dollars)*	$33,609	$10,624	$179	$3,893	$ 48,305
Return on Investment	23%	38%	17%	4%	25%

*SG&A allowance for each channel is 25% of that channel's revenues.
†Invested capital allowance for each channel is 42% of that channel's revenues.

Many companies, however, spread capacity costs over budgeted volume. Returning to our example, if demand exists for only 500,000 units, a traditional cost system will report that each unit cost $10 to build ($5 million/500,000) even though workers and machines have become no less efficient in terms of what they could produce. Such a procedure causes product costs to fluctuate erratically with changes in assumed production volume and can lead to the "death spiral." A downturn in forecast demand creates idle capacity. The cost system reports higher costs. So management raises prices, which guarantees even less demand in the future and still higher idle capacity costs.

The second exclusion from an activity-based cost system is research and development for entirely new products and lines. We recommend splitting R&D costs into two categories: those that relate to improvements and modifications of existing products and lines and those that relate to entirely new products. The first category can and should be traced to the products that will benefit from the development effort. Otherwise, the costs will be spread to products and lines that bear no relationship to the applied R&D program.

The second category is a different animal. Financial accounting treats R&D as a cost of the period in which it takes place. The management accounting system, in contrast, should treat these costs as investments in the future. Companies engaged in extensive R&D for products with short life cycles should measure costs and revenues over the life cycle of their products. Any periodic assessment of product profitability will be misleading, since it depends on the arbitrary amortization of investment expenditures including R&D.

Strategic Implications

The examples we've discussed demonstrate how an activity-based cost system can lead to radically different evaluations of product costs and profitability than more simplistic approaches. It does not imply that because some low-volume products (lavender pens or valve 3) now are unprofitable, a company should immediately drop them. Many customers value having a single source of supply, a big reason companies become full-line producers. It may be impossible to cherry pick a line and build only profitable products. If the multiproduct pen company wants to sell its profitable blue and black pens, it may have to absorb the costs of filling the occasional order for lavender pens.

Once executives are armed with more reliable cost information, they can ponder a range of strategic options. Dropping unprofitable products is one. So is raising prices, perhaps drastically. Many low-volume products have surprisingly low price elasticities. Customers who want lavender pens or valve 3 may be willing to pay much more than the current price. On the other hand, these customers may also react to a price increase by switching away from low-volume products. That too is acceptable; the company would be supplying fewer money-losing items.

...to a Solid Performer

Profits by Commercial Distribution Channel (New System)

	Contract	Industrial Suppliers	Government	OEM	Total Commercial
Gross Profit *(from previous table)*	$27,375	$10,284	$136	$2,461	$40,256
Selling Expenses* *(all in thousands of dollars)*					
Commission	$ 4,682	$ 1,344	$ 12	$ 372	$ 6,410
Advertising	132	38	0	2	172
Catalog	504	160	0	0	664
Co-op Advertising	416	120	0	0	536
Sales Promotion	394	114	0	2	510
Warranty	64	22	0	4	90
Sales Administration	5,696	1,714	20	351	7,781
Cash Discount	892	252	12	114	1,270
Total	$12,780	$ 3,764	$ 44	$ 845	$17,433
G&A *(in thousands of dollars)*	$ 6,740	$ 2,131	$ 36	$ 781	$ 9,688
Operating Profit *(in thousands of dollars)*	$ 7,855	$ 4,389	$ 56	$ 835	$13,135
Operating Margin	10%	17%	13%	9%	12%
Invested Capital*	$33,154	$10,974	$184	$2,748	$47,060
Return on Investment	24%	40%	30%	30%	28%

*Selling expenses and invested capital estimated under an activity-based system.

More accurate cost information also raises strategic options for high-volume products. Plant II might consider dropping its prices on blue pens. The old cost system, which shifted overhead charges onto these high-volume products, created a price umbrella that benefited focused competitors like Plant I. Pricing its core product more competitively might help Plant II reverse a market-share slide.

Managers in the building supplies company we described took several profit-enhancing steps after receiving the revised cost data by distribution channels. They began emphasizing the newly attractive OEM segment and any new business where marketing costs would be well below the company average.

Information generated by an activity-based cost system can also encourage companies to redesign products to use more common parts. Managers frequently exhort their engineers to design or modify products so they use fewer parts and are easier to manufacture. But these exhortations will ring hollow if the company's cost system cannot identify the benefits to design and manufacturing simplicity. Recall valve 7, a low-volume product made from components fabricated in large volumes for other products. Now that the company can quantify, using activity-based techniques, the impressive cost benefits of component standardization, the entire organization will better understand the value of designing products for manufacturability.

Likewise, activity-based costing can change how managers evaluate new process technologies. Streamlining the manufacturing process to reduce setup times, rationalizing plant layout to lower material handling costs, and improving quality to reduce postproduction inspections can all have major impacts on product costs—impacts that become visible on a product-by-product basis with activity-based costing. A more accurate understanding of the costs of specialized products may also make computer-integrated manufacturing (CIM) look more attractive, since CIM is most efficient in high-variety, low-volume environments.

Activity-based costing is not designed to trigger automatic decisions. It is designed to provide more accurate information about production and support activities and product costs so that management can focus its attention on the products and processes with the most leverage for increasing profits. It helps managers make better decisions about product design, pricing, marketing, and mix, and encourages continual operating improvements.

Reprint 88503

6.2 Activity-Based Costing in Service Industries

By William Rotch

ABC has mainly been applied to manufacturing companies, but it can also prove useful to service enterprises. This article identifies how ABC is applied in manufacturing settings, then discusses any special challenges that service companies encounter in trying to use ABC systems.

A number of articles and cases recently have described and analyzed activity-based costing (ABC). Since ABC has mainly been applied to manufacturing companies, however, the question arises whether ABC can also be used in service businesses. To answer this question, this article first considers how ABC works in manufacturing settings to identify key characteristics of both the manufacturing setting and of the cost systems. This background provides a point of departure for considering the suitability of ABC to service businesses and also any special challenges that arise in using ABC in those businesses.

ABC SYSTEMS IN MANUFACTURING

As a number of recent articles and cases explain,[1] ABC deals with indirect costs, which are costs that are not easily traceable to outputs (output being defined as all tangible and intangible benefits provided for customers). In the short run, many indirect costs are fixed. ABC, however, implicitly takes a longer-term view by recognizing that, over time, these indirect costs can be changed and hence are relevant to management choices.

The following two sections explain the two primary benefits derived from using ABC.

More accurate costs for output. More accurate costs are possible when support costs (e.g., setup and inspection) that are not driven by volume are allocated to products by using a volume-related base (traditionally, direct labor hours or dollars). By shifting the allocation base to an activity that is related to output or output characteristics, the link between the use of resources and product output becomes more accurate. An activity such as "product runs," for example, could be used to capture all the setup, inspection, and material-handling costs caused by production runs. Then, if a company has product diversity in terms of run length, short-run products will not be undercosted and long-run products will not be overcosted. How much the accuracy of costs improves depends on how different the products are in their use of the activities.

Behavioral influence. Besides more accurate output costs, ABC can provide benefits by influencing the behavior of design engineers, production managers, or marketing strategies. Identifying and costing activities provide potentially powerful information such as the following:

- Knowing the high cost of parts handling (a defined activity) can encourage design engineers to simplify production design;
- Recognizing that volume-based overhead allocations can give false signals (e.g., knowing that automation-related support costs will not go down by reducing direct labor) helps production managers determine the optimum level of production technology); and
- Knowing even the approximate cost of various customer services can guide marketing strategists toward a profitable mix of service and volume.

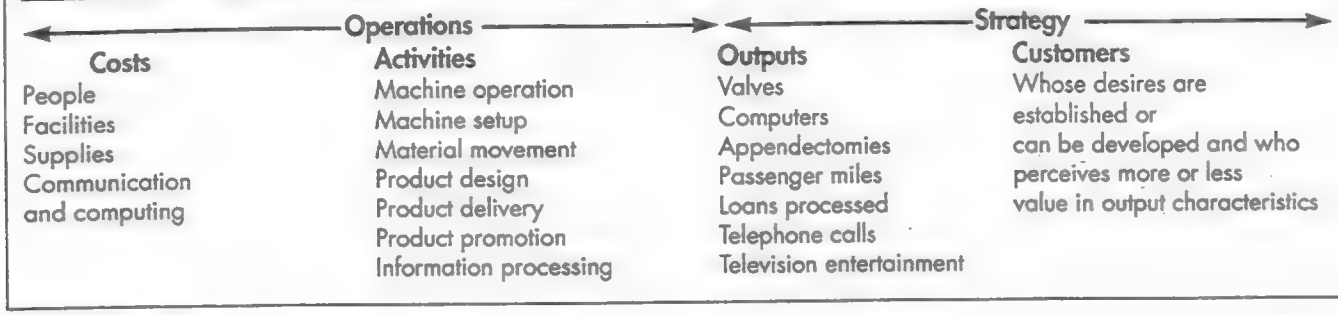
Relationship between activities and strategy. Activities and strategies are closely linked in ABC because strategic choices drive activities. ABC deals with activities and costs that can be changed only gradually, which reflects the long-term perspective taken by ABC and its concern with strategic issues. Support costs ordinarily cannot be changed much in one week. Over time, however, changes that occur in a company's production methods, product design, and marketing strategy ultimately affect the company's indirect support costs. This important linkage is illustrated by Exhibit 1, which shows the relationship between strategy and activities (which, together, comprise the firm's operations).

Strategy. A company's strategy can be seen as a plan to provide certain outputs to attract and serve customers. Those outputs, whether manufactured products or units of service, have characteristics that cause certain activities to take place, and those activities cost money. When a company's strategy changes—say, toward greater customer service and shorter production runs—certain activities (e.g., setups and product design) occur more often or are used more. The costs of these activities, therefore, increase. Unless they can measure the link between output characteristics (e.g., better customer service) and activities (e.g., improved product design because of an expanded product design department), managers cannot compute the cost of strategic choices. If they use traditional systems based on direct labor hours or machine hours, these managers may well have misleading information.

Several examples of how strategic choices can influence or drive activities are given in the following cases.

The Schrader Bellows case. In the Schrader Bellows case,[2] the company's strategy was to offer a broad line of valves and to respond favorably to customer requests for rush orders and specially designed products. The result was many short runs and interruptions of longer runs. All support activities that were driven by the frequency of production

EXHIBIT 1
LINK BETWEEN STRATEGY AND ACTIVITIES



runs were heavily used (the application of ABC to Schrader Bellows is discussed next).

Siemens Electric Motor Works. The Siemens Electric Motor Works case[3] found that 40 percent of its support-related manufacturing costs (or 10 percent of total costs) were driven by two kinds of activities: order processing and the handling of special components. The company's strategy had led it toward producing custom motors and away from long-run, commodity-type motors. As a result, 90 percent of all orders were for custom motors. The average order was for less than ten units although almost half the motors sold were on orders for 100 or more units. The company's strategy clearly made both order processing and component handling into large and costly activities, especially for small production runs.

A hospital. A Pennsylvania hospital decided in 1986 to become certified as a trauma center. That strategic decision set in motion a number of activities and affected some existing ones. The hospital recruited four doctors to staff the trauma center so that it could be covered twenty-four hours a day. Each of these doctors received compensation guarantees. Other incremental one-time and continuing expenses were incurred for facilities, equipment, training, and support staff. Although a few activities and staff members were unique to the trauma center, many were used by other hospital services. A continuing review of the strategy of maintaining a trauma center benefited from knowing the link between the new trauma center's work and related support activities.

ABC PROCESS

There are three essential steps in establishing an ABC system:

1. Defining the activities that support output (which often requires defining output—or characteristics of output—in a way that describes how the output drives activities). In the Schrader Bellows case, for example, the traditional output definition would be "a valve" with certain specifications. With ABC, the output is defined as "a valve with a particular average number of units per run." This output definition highlights the activity "making runs," which is different from making units. Note also that the activity "making runs" is chosen to capture output diversity because runs in Schrader Bellows varied greatly in length.
2. Defining the links between activities and outputs. Again using the Schrader Bellows example, the link between the activity "runs" and the output would be "cost per run" and the "average units per run" (or runs per unit) for each valve produced.
3. Developing the cost of activities (often costs are customarily gathered by function or organizational unit, so special allocation methods have to be used to relate costs to activities). In the Schrader Bellows case, the activity "making runs" was supported by a number of functions (such as setup, inspection, material handling, and labor reporting). The costs of those functions combined to become the cost of the activity "making runs."

Schrader Bellows. While each of these steps is essential, the difficulties that they present vary from company to company. Exhibit 2, for example, portrays these steps for the Schrader Bellows case. The exhibit shows how both the traditional and the new cost systems looked, using the same framework.

Under the "old way," the activities are the work done in manufacturing departments, and the link is overhead cost per direct labor hour. The "new way," by contrast, uses a number of activities (e.g., purchasing and shipping), each with its own appropriate link to output. (Exhibit 2 focuses on only one activity: setting up and making a run.)

The Schrader Bellows ABC system was not easy to set up. All three steps required some ingenuity. Activities had to be defined so that they reflected what people in the support groups actually did and also in a way that could be linked to product output. Relating costs to activities required data gathering on how people spent their time, which was not information that was readily available.

Structure of ABC systems. At this point, one might ask whether ABC is just a traditional two-stage overhead allocation system that uses more overhead cost pools and a variety of appropriate allocation bases. Technically, ABC is just that, but companies using it seem to have obtained some important benefits that are not obvious when viewing cost systems from an overhead cost pool perspective.

EXHIBIT 2
THE SCHRADER BELLOWS CASE: AN ABC CASE STUDY

The Old Way

Support Costs	Links	Activities	Links	Products
Inventory management Production control Purchasing Setup Quality control Engineering	Mostly based on direct labor; setup on estimates of time	Manufacturing departments (machining, assembly, etc.)	Overhead rate labor hour	Valves with specified amount of direct labor

The New Way (ABC Costing)

Costs	Links	Activities	Links	Products
Same as above	Percentage of time spent in support of specified activities	A *run* Setting up and making a run of a component or finished product	Cost per run	Run cost of products with specified number of units and runs
		(*Other activities* Purchasing Shipping Handling customer orders Direct labor etc.)	Other appropriate links	Cost of purchasing Cost of shipping Cost of handling order Overhead related to labor Total cost per item

One benefit is that learning about the links between output characteristics and activities helps managers make product decisions directly, even without dollar figures. A circuit board manufacturer discovered, for example, that certain board designs require more hand work. The manufacturer also recognized that the hand work was expensive and prone to quality problems. Therefore, the manufacturer concluded that changes in board design could eliminate the manual operation. Alternatively, if changes were not feasible for particular applications, the price of the boards might be raised. Defining the linkages between board designs and product costs, therefore, helped the manufacturer identify where improvements could be made.

Another benefit seems to arise from defining activities according to how they relate to output characteristics rather than in relation to organizational units, which are more oriented toward input characteristics. It is obvious, for example, that the cost of a setup is the time that setup people spend in setting up for a new run. But if the activity is defined more broadly as a production run, many other costs are also caused by setups, including the following:

- Material movement;
- Inspection; and
- Labor reporting.

Although the activity "setups" is indeed an overhead pool, notice that the pool is defined by an *output-related activity* (runs) rather than by an organizational unit (the setup department).

ABC may also make it easier to include activities outside the factory walls (e.g., marketing and distribution) in product costs. Reorienting and broadening the definition of activities in this way makes the allocation of overhead cost pools more useful in making strategic choices that depend on product costs.

Another benefit of ABC comes from its untraditional way of looking at the relationship between outputs and activities. ABC rejects any clear split between fixed and variable costs and accepts the notion that many costs that are usually considered fixed in fact change over time largely because of changes in strategy. Therefore, not only are these "fixed" costs relevant for strategic decisions, but also the most effective way to control them may be through changes in output strategies.

When management simplifies a product, as IBM did with its ProPrinter, the need for many activities is reduced, so costs can be cut. IBM achieved significantly lower product cost by designing the ProPrinter with fewer parts, thus reducing the costs of parts manufacturing, storage, and handling. By highlighting non-value-adding activities (such as labor reporting) and high-cost activities (such as managing part numbers), ABC systems direct management attention to likely areas for improvement.

The structure of an ABC system (with its use of activity cost pools), therefore, resembles the structure of a traditional overhead cost pool system. The benefits of an ABC system lie in choosing activities that are oriented toward output characteristics and that capture output diversity. The analytical process of defining activities and of establishing their

linkages to output helps managers to evaluate the cost of strategic choices and to discover ways to reduce costs.

ABC SYSTEMS IN SERVICE ENTERPRISES

Given that ABC systems work in a manufacturing setting, can they also work in service enterprises? If so, what would an ABC system for a service company look like, and would the service setting present any special challenges?

Although differences between manufacturing and service enterprises tend to get blurred because of an emphasis on service in the strategies of many manufacturing enterprises, service enterprises do have several distinctive characteristics:

- Output is often harder to define;
- Activity in response to service requests may be less predictable; and
- Joint capacity cost represents a high proportion of total cost and is difficult to link to output-related activities.

Output in a service enterprise. Output in a service enterprise is sometimes described as a "package of service benefits,"[4] many of which are intangible: for example, speed of service, quality of information, or satisfaction provided. But—just as in a manufacturing environment—these benefits drive activities that cost money. Viewed in this way, service enterprises have characteristics similar to manufacturing although the intangible nature of service output makes costing more difficult.

Despite these difficulties, service businesses are beginning to develop systems that look very much like ABC even though that term is usually not used. Here are some examples, including discussions of any particular difficulties that these service enterprises encountered in implementing an ABC system.

ALEXANDRIA HOSPITAL

Consider another hospital, Alexandria Hospital, for example. A hospital's "product" can be defined as a patient's stay and treatment. The total charge for each stay includes charges for many different services (e.g., tests, medications, treatments, supplies, and a daily rate). The daily rate usually covers three kinds of costs:

- "Hotel" cost for the room;
- Meal costs; and
- Costs of nursing services.

In most hospitals, a different daily rate is charged for different types of care. The private room charge for stays in the intensive care unit, for example, is higher than the private room charge for stays in the obstetrics unit. Within each unit, however, all patients are charged the same daily rate for the same type of room.

The Alexandria hospital recognized that patients in the same unit require and receive different amounts of nursing care and that overall nursing care accounted for about half the total daily rate. There was diversity in service provided, and the amount of money involved was significant.

In a recently installed system[5] designed to measure more accurately how much nursing care each patient requires, each unit's head nurse rates each patient and arrives at a level of "acuity" on a 5-point scale. Level 5 patients in the cardiac care unit, for example, need more than ten times as much nursing care as level 1 patients (twenty-four hours versus two hours). The hospital's financial office uses projected costs and patient mix to compute a nursing service charge per day for each level of acuity, and the patient's bill shows nursing service as a separate line from the daily rate. The result is that each patient's charges more accurately reflect the actual service received. In addition, the acuity ratings are used to prepare a flexible budget for nursing in each unit.

The hospital's new system is actually an ABC system (although the hospital does not call it that). Under the previous system, the activity was "patient care and feeding" (see "Old Way" under Exhibit 3), and the hotel, feeding, and nursing costs were bundled into one cost per day.

The new system redefines the hospital's "product" by specifying characteristics that related to separable activities: "nursing care" and "occupancy and feeding" (see "New Way" under Exhibit 3). The nursing activity is driven by acuity levels. "Occupancy and feeding" was considered a daily cost that was the same for all acuity levels.

UNION PACIFIC[6]

In any given hour, the Union Pacific Railroad operates up to 200 trains, covers over 21,500 route miles (using 2,400 locomotives), and moves some 80,000 freight cars. Thousands of shipments are processed every day, each different from the others. To cost this traffic, Union Pacific uses a form of ABC that is sufficiently real time to recognize that the cost of a particular shipment is influenced by the other shipments that ride with it. Exhibit 4 depicts this system.

If Union Pacific were to use a costing system with one all-encompassing activity, that activity would be "moving freight," and the link to output would be cost per ton mile. But since ton miles of freight are not all alike, Union Pacific devised a system that relates characteristics of freight shipments to activities and the costs of those activities.

Essentially none of the railroad's operating costs relates directly to a shipment; all are support costs. The costs are collected by function and organizational unit. In that form, however, they cannot easily be linked to the distinctive characteristics of shipments. To accomplish this goal, Union Pacific has defined a series of activities that can be linked to shipments and developed a mechanism for collecting the costs of those activities. For example, each shipment will be on a freight car that will be handled one or more times in one or more switching yards (an activity). The route and train specifications determine how many switching minutes will be needed. The cost of that switching activity is an accumulation of several functional

EXHIBIT 3
ALEXANDRIA HOSPITAL: EXAMPLE OF AN ABC IN A HOSPITAL

The Old Way

Costs	Links	Activities	Links	Service Output
Nurses Nursing supervision and support supplies Facilities Dietary Overhead	Costs related to patient nursing, occupancy, and feeding	Patient care, including nursing, occupancy, and feeding	Cost per day (about $500)	A patient day's stay in the hospital

The New Way

Costs	Links	Activities	Links	Service Output
Nurses Nursing supervision and support	Costs related to nursing and acuity level	Nursing care that varies with acuity	Cost per day for each acuity level ($50 to $600)	Nursing service for specified acuity level
Supplies Facilities Dietary Overhead	Costs related to hotel and dietary functions	Occupancy and feeding	Cost per day ($335)	Occupancy per day Total cost per day

EXHIBIT 4
UNION PACIFIC: EXAMPLE OF ABC FOR A RAILROAD

Support Costs[a]	Link	Activity	Link	Service Output or Output Characteristic
Maintenance of ways and structures	Groups of support costs allocated to activities in appropriate ways	Moving freight trains	Cost per gross ton mile	Gross ton miles per shipment
Equipment maintenance and depreciation		Switching freight trains	Cost per yard/train switching minute	Yard/train switching minutes per shipment
Transportation, including switching costs and fuel station platform labor		Handling and depreciation of freight cars	Cost per freight car mile	Freight car miles per shipment
		Handling freight in and out of freight cars	Cost per ton of freight	Tons of freight per shipment Total cost of a specific shipment

[a]Each of these groups of costs corresponded to a function of railroad operation as well as the organization structure, and each group of costs supported three or four of the activities.

Source: Adapted from teaching notes prepared by Professor Robert S. Kaplan for three cases he wrote about Union Pacific in the *Harvard Business School Case Series (cases 186–176, 186–177, and 186–178).*

support costs, such as maintenance of track in the yards, depreciation and maintenance of switching equipment, and labor costs in the yards.

Union Pacific's system enables it to develop the actual cost of each shipment, gathering data each day from many locations on movements of trains and shipments. Furthermore, by using the same activity cost information, Union Pacific can estimate the cost of future shipments, which helps the marketing department identify profitable business.

EXHIBIT 5
ADDITIONAL AMTRAK: EXAMPLE OF ABC FOR A RAILROAD

Costs and Activities	Percent	Link	Service Output
Train and engine crews[a]	18%	Direct charge	Trip-specified consist
Fuel	11	Estimate based on route specs	Trip-specified consist
Yard and mainline operations; other transp.	6	Cost per train trip	Trip
Locomotive maintenance	6	Locomotive miles	Trip-specified locomotive(s)
Car maintenance	18	Cost per car miles (80%) and trips (20%)	Trip-specified consist
Maintenance of way	3	Rate per train unit per track mile	Trip
Onboard service	10	Direct charge	Trip-specified consist
Station services	3	Cost per route and per train	Trip-specified route
			Total trip cost
Depreciation, administration, etc.	18	Percentage of total cost	Route-specified frequency
Sales, marketing, reservations	7	Percentage of projected sales	Sales
	100%		Cost of route with a given frequency and consist

[a]Approximate percentage of total cost.

AMTRAK[7]

Although many of Amtrak's costs are similar to Union Pacific's, the unit of service output is different. For Union Pacific, the output is a shipment. For Amtrak, the output is service on a specific route with a defined frequency of trips and a specified makeup of cars and engine (the "consist"). Whereas Union Pacific's diversity of output precluded use of ton miles as the definition of output, Amtrak's diversity meant that the single definition "route miles" would not produce accurate costs. Exhibit 5 depicts Amtrak's costing system.

Cost categories are the same as activities in this instance. Of all the costs listed, only train and engine crews and on-board service are directly related to a train on a route. All the others costs are indirect. Most of them, however, represent activities that are closely related to departments and functions for which costs can be computed without extensive allocation.

For Amtrak, the problem is in defining the links between activities and output. The links between some are easy-fuel, for example. Even though fuel is not metered by train, engineered consumption standards can be reliably used to estimate fuel consumption by route. Maintenance is more difficult, partly because locomotives and cars are shifted around from route to route. Output diversity is also problematical. For example, does a 400-mile trip cause 4 times as much locomotive maintenance as a 100-mile trip? Probably not although Amtrak has used a straight mileage measure (that particular type of diversity was evidently not considered material).

Defining the links between activity usage and product definition may also involve deciding which activity costs should be considered variable. If a strategic, longer-range perspective is taken, all (or almost all) costs are variable. Amtrak has called variable costs "short-term avoidable," a concept that was developed in the political context of decisions about dropping specific routes. Specific costs (or percentages of costs) are defined as short-term avoidable.

For other decisions (about frequency or consist, for example) different definitions of relevant costs are used. A particularly thorny issue has been how to handle costs that follow a step function. A certain station and its staff might be able to handle ten trains a day. Additions in frequency from six to ten trains would, therefore, cause no increase in cost, but adding an eleventh train would increase costs significantly. Should the linkage between activity and "product" assume average activity cost or somehow recognize the actual costs? In the expectation that a series of decisions are likely to come along, average costs probably make more sense.

With Amtrak, defining service output and support activities has been fairly clear. Establishing the links between the two, however, has proven difficult.

DATA SERVICES, INC.[8]

Data Services, Inc., a subsidiary of Armistead Insurance Company, was set up to market Armistead's unused third shift of computer time. By the end of two years, Data Services had established a service that provided data analysis for about forty fast-food franchisors, each with varying numbers of units. The data analysis was performed on each unit. The number of units per franchise ranged from under five to several hundred. Data Services charged an installation fee and a monthly service fee per unit. Unfortunately, the operation taken as a whole was not profitable. Armistead Insurance Company wanted to know what the trouble was.

This case requires defining the service output in a way that will suggest useful links to the support activities. Data Services was not just selling computer time. The company was providing an information system that required four types of support activities:

- Selling the system;
- Installing the system;

- Maintaining relations with each franchisor: and
- Processing data from each unit.

There were costs associated with each of these activities although Data Services charged only for installation and data processing.

Exhibit 6 depicts Data Services' old and new ways of costing its service output. Under the new system, the costs that were previously collected by function were allocated to the three distinct activities shown in the center column of Exhibit 6. This allocation made it possible for Data Services to compute the cost of acquiring a customer (including the installation costs) and the cost of servicing a customer (including the cost of monthly visits to each franchisor's headquarters plus the cost of servicing each of the franchisor's units). The issues involved in determining pricing and market strategy for Data Services focused on the different sizes of franchisors. Specifically, what was the relative profitability of franchisors of different sizes, and how should that information influence Data Services' marketing and pricing? Only by separating out customer acquisition costs and linking service costs to different sizes of customers could Data Services see the strategic reorientation needed to become profitable. The result was that Data Services charged higher per-unit fees for small franchisors and paid special attention to streamlining the customer-acquisition process.

ABC FOR SERVICE INDUSTRIES

The two questions stated at the beginning of this article were whether ABC could be used in service enterprises and, if so, whether doing so presented any special challenges. To answer the first question, it appears that ABC can indeed be useful to service enterprises, at least in some instances. Robin Cooper and Robert S. Kaplan have pointed out the conditions that make manufacturing enterprises good candidates for ABC (e.g., diversity of resource consumption; products and resource consumption not correlated with traditional, volume-based allocation measures).[9] The implication is that while ABC is useful in some manufacturing enterprises, it may not be useful in others.

The Cooper-Kaplan conditions also apply to service enterprises. All the examples described in this article show diversity of resource consumption. Traditional allocation bases fail to capture that diversity:

- In the Alexandria hospital example, patients require different levels of nursing care. Although this diversity is significant, it was missed altogether by the all-in-one rate that the hospital had formerly used in charging patients.
- In the Union Pacific example, the cost differences between shipments was not captured by a gross-ton-mile measure.
- In the Amtrak example, the cost of a route could not be computed accurately using a single measure such as route miles.
- In the Data Services example, the varying size of customers in terms of units served per franchisor created output diversity. The all-inclusive monthly expense for servicing franchisors did not reflect that diversity.

Identifying and costing activities. Identifying and costing activities may reveal opportunities for more effi-

EXHIBIT 6
DATA SERVICES, INC.: ACTIVITY-BASED PRODUCT COSTING IN A SERVICE INDUSTRY

The Old Way

Costs	Links	Activities	Links	Services
Data entry Service agents SG&A Computer Travel, etc.		Running Data services (the total enterprise)	Cost per month or year	Data analysis service for customers

The New Way

Costs	Links	Activities	Links	Services
Data entry Service agents SG&A Computer Travel, etc.	Cost of specific visits Travel, analysis Setup	Customer acquisition and installation	Cost per succesful customer acquisition	Customer under contract Total customer acquisition cost
	Cost of specific visits Travel	Servicing customers	Cost per month per customer company	Customer satisfaction
	Cost of data analysis	Servicing units	Cost per unit or shift served	Data reports to the units Total customer service cost

cient operations. The Data Services case provides an example because Data Services chose to isolate and cost out customer acquisition activities. This decision made it possible to focus on opportunities to streamline the selling process. These opportunities might not have been discovered if the company had not learned how high the selling costs really were.

Special challenges. The differences between service enterprises are at least as great as the differences between service and manufacturing enterprises as a whole. However, service companies and manufacturing companies can present similar problems. Schrader Bellows and Data Services, for example, have much in common: both have product setup costs and other costs that vary with volume. Both must also grapple with strategic issues about selling and pricing products with varying unit volumes.

However, service enterprises can present special difficulties in allocating costs to activities. Consider, for example, the hospital trauma center. Certain personnel and facilities costs are directly attributable to the center. But the center also draws on other resources, such as helicopter transportation, laboratory work, and regular nurses, physicians, and staff. Specifying resource use by the trauma center is difficult, so it is not easy to define the links between the trauma center as an element in the hospital's strategy and the activities that support it. The need to be responsive to unpredictable external demands adds another element of uncertainty. Service cannot be inventoried, so unused capacity is often an unavoidable cost.

Output diversity. Service enterprises also present difficulties in defining output diversity. In manufacturing, parts are specified, and it is clear when one product uses many parts and another uses only a few. But in service settings, diversity that draws on support activities in different ways may be hard to pin down. For example, a bank's checking account customers do not all use the same services or provide the same revenue. To try to control this tendency, some banks have begun to segment customers and offer varying service packages. Each package drives a known mix of activities that the bank hopes will please the customer and that will have a predictable cost. Such a strategy does not eliminate diversity, but it does make the diversity somewhat more measurable.

Some service enterprises have quite clearly definable measures of output diversity and clear links between relevant output characteristics and support activities. The four cases described in this article are examples. Other service enterprises are far more difficult to analyze. For such companies, implementing an ABC system would be expensive and the benefits of doing so would be questionable: The information produced is likely to have a wide range of uncertainty.[10] In such situations the basic framework used in Exhibits 2–6 can still be followed but without the efforts to quantify the links. Certain kinds of service may be known as "hard to execute." As a result, they may draw excessively on support activities. In a printing plant, for example, certain jobs with tight schedules may require more attention than jobs with more relaxed timetables. The jobs with tight schedules interrupt the smooth flow of work and place extra burdens on setup activity.

Other support activities may be identified as not being essential to the service strategy. Although this framework fails to quantify costs and relationships, the conclusion that can be drawn from it can still prove helpful.

ABC can be successfully applied in some service enterprises. It provides an analytical framework that can be useful even in settings where it would be impractical actually to quantify costs and relationships.

Notes

1. A number of articles have described and analyzed ABC systems in the past few years. At the center of these is Robin Cooper's four-part series called "The Rise of Activity-Based Costing" in the *Journal of Cost Management:* "Part One: What Is an Activity-Based Cost System?" (Summer 1988): 45–53; "Part Two: When Do I Need an Activity-Based Cost System?" (Fall 1988): 41–48; "Part Three: How Many Cost Drivers Do You Need, and How Do You Select Them?" (Winter 1989): 34–54; "Part Four: What Do Activity-Based Cost Systems Look Like?" (Spring 1989): 38–49.

Note also these other important articles on ABC systems: H. Thomas Johnson, "Activity-Based Information: Blueprint for World-Class Management,." *Management Accounting* (June 1988): 23–30; Robin Cooper and Robert S. Kaplan, "Measure Costs Right: Make the Right Decisions," *Harvard Business Review* (September–October 1988): 986.

An application of ABC is described in the following articles: Gary B. Frank, Steven A. Fisher. and Allen R. Wilkie, "Linking Cost to Price and Profit," *Management Accounting* (June 1989): 22.

Among the cases that deal with ABC systems are the following: Robin Cooper, "Schrader Bellows," *Harvard Business School Case Series, 186–272;* Robert S. Kaplan, "John Deere Component Works (A) and (B)," *Harvard Business School Case Series 187–107/108;* Robin Cooper and Peter B. B. Turney, "Tektronix: Portable Instruments Division (A), (B), and (C)," *Harvard Business School Case Series 188–142/143/144;* Robin Cooper and K. H. Wruck, "Siemens Electric Motor Works (A) and (B)," *Harvard Business School Case Series 189–089/90.*

2. See Cooper, "Schrader Bellows."

3. See Cooper and Wruck, "Siemens Electric Motor Works."

4. See, e.g., W. E. Sasser, R. P. Olsen, and D. D. Wyckoff, *Management of Service Operations* (Boston: Allyn and Bacon, 1978).

5. This system is described in William Rotch and W. Schell, "Alexandria Hospital." *University of Virginia Darden Graduate Business School Case No. UVA-C-2007* (1987).

6. This system is described in Robert S. Kaplan, "Union Pacific Introduction, (A) and (B)," *Harvard Business School Case Series 186–176/177/178.*

7. This system is described in William Rotch and S. Allen, "Amtrack Auto-Ferry Service," *University of Virginia Darden Graduate Business School Case No. UVA-C-988.*

8. The names of these entities have been disguised. This cost system is described in J. L. Colley. Jr., R. A. Gary IV, J. C. Reid, and R. C. Simpson III, "Data Services, Inc. (B)," *University of Virginia Darden Graduate Business School Case No. UVA-OM-582.*

9. See Cooper and Kaplan, "Measure Costs Right: Make the Right Decisions."

10. See "The Rise of Activity-Based Costing—Part Two: When Do I Need an Activity-Based Cost System?" Cooper discusses the cost/benefit balance. If applied to many service enterprises, the cost curve will rise steeply with increasing accuracy requirements, and the benefit curve, shown as the cost of errors, will be uncertain. See also Robin Cooper, "You Need a New Cost System When. . . ," *Harvard Business Review,* (January–February 1989): 77–82, in which he uses the same cost/benefit curves.

4
WHARTON REPROGRAPHICS

Must CIM be justified by faith alone?

Robert S. Kaplan

Reprinted from

Harvard
Business Review

No. 86204

"Managers need not—and should not—abandon the effort to justify computer-integrated manufacturing on financial grounds. Instead, they need ways to apply the DCF approach more appropriately."

Must CIM be justified by faith alone?

Robert S. Kaplan

When the Yamazaki Machinery Company in Japan installed an $18 million flexible manufacturing system, the results were truly startling: a reduction in machines from 68 to 18, in employees from 215 to 12, in the floor space needed for production from 103,000 square feet to 30,000, and in average processing time from 35 days to 1.5.[1] After two years, however, total savings came to only $6.9 million, $3.9 million of which had flowed from a one-time cut in inventory. Even if the system continued to produce annual labor savings of $1.5 million for 20 years, the project's return would be less than 10% per year. Since many U.S. companies use hurdle rates of 15% or higher and payback periods of five years or less, they would find it hard to justify this investment in new technology—despite its enormous savings in number of employees, floor space, inventory, and throughput times.

The apparent inability of traditional modes of financial analysis like discounted cash flow to justify investments in computer-integrated manufacturing (CIM) has led a growing number of managers and observers to propose abandoning such criteria for CIM-related investments. "Let's be more practical," runs one such opinion. "DCF is not the only gospel. Many managers have become too absorbed with DCF to the extent that practical strategic directional considerations have been overlooked."[2]

Faced with outdated and inappropriate procedures of investment analysis, all that responsible executives can do is cast them aside in a bold leap of strategic faith. "Beyond all else," they have come to believe, "capital investment represents an act of faith, a belief that the future will be as promising as the present, together with a commitment to making the future happen."[3]

But must there be a fundamental conflict between the financial and the strategic justifications for CIM? It is unlikely that the theory of discounting future cash flow is either faulty or unimportant: receiving $1 in the future is worth less than receiving $1 today. If a company, even for good strategic reasons, consistently invests in projects whose financial returns are below its cost of capital, it will be on the road to insolvency. Whatever the special values of CIM technology, they cannot reverse the logic of the time value of money.

Surely, therefore, the trouble must not lie in some unbreachable gulf between the logic of DCF and the nature of CIM but in the poor application of DCF to these investment proposals. Managers need not—and should not—abandon the effort to justify CIM on financial grounds. Instead, they need ways to apply the DCF approach more appropriately and to be more sensitive to the realities and special attributes of CIM.

Technical issues

The DCF approach most often goes wrong when companies set arbitrarily high hurdle rates for evaluating new investment projects. Perhaps they believe that high-return projects can be created by setting high rates rather than by making innovations in product and process technology or by cleverly building and exploiting a competitive advantage in the marketplace. In fact, the discounting function serves only to make cash flows received in the future equivalent to

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cash flows received now. For this narrow purpose—the only purpose, really, of discounting future cash flows—companies should use a discount rate based on the project's opportunity cost of capital (that is, the return available in the capital markets for investments of the same risk).

It may surprise managers to know that their real cost of capital can be in the neighborhood of 8%. (See Part I of the *Appendix* at the end of the article.) Double-digit hurdle rates that, in part, reflect assumptions of much higher capital costs are considerably wide of the mark. Their discouraging effect on CIM-type investments is not only unfortunate but also unfounded.

Companies also commonly underinvest in CIM and other new process technologies because they fail to evaluate properly all the relevant alternatives. Most of the capital expenditure requests I have seen measure new investments against a status quo alternative of making no new investments—an alternative that usually assumes a continuation of current market share, selling price, and costs. Experience shows, however, that the status quo rarely lasts. Business as usual does not continue undisturbed.

In fact, the correct alternative to new CIM investment should assume a situation of declining cash flows, market share, and profit margins. Once a valuable new process technology becomes available, even if one company decides not to invest in it, the likelihood is that some of its competitors will. As Henry Ford claimed, "If you need a new machine and don't buy it, you pay for it without getting it."[4] (For a more realistic approach to the evaluation of alternatives, see Part II of the *Appendix* at the end of the article.)

A related problem with current practice is its bias toward incremental rather than revolutionary projects. In many companies, the capital approval process specifies different levels of authorization depending on the size of the request. Small investments (under $100,000, say) may need only the approval of the plant manager; expenditures in excess of several million dollars may require the board of directors' approval. This apparently sensible procedure, however, creates an incentive for managers to propose small projects that fall just below the cut-off point where higher level approval would be needed. Over time, a host of little investments, each of which delivers savings in labor, material, or overhead cost, can add up to a less-than-optimal pattern of material flow and to obsolete process technology. (Part III of the *Appendix* shows the consequences of this incremental bias in more detail.)

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Introducing CIM process technology is not, of course, without its costs. Out-of-pocket equipment expense is only the beginning. Less obvious are the associated software costs that are necessary for CIM equipment to operate effectively. Managers should not be misled by the expensing of these costs for tax and financial reporting purposes into thinking them operating expenses rather than investments. For internal management purposes, software development is as much a part of the investment in CIM equipment as the physical hardware itself. Indeed, in some installations, the programming, debugging, and prototype development may cost more than the hardware.

There are still other initial costs: site preparation, conveyors, transfer devices, feeders, parts orientation, and spare parts for the CIM equipment. Operating and maintenance personnel must be retrained and new operating procedures developed. Like software development, these tax-deductible training and education costs are part of the investment in CIM, not an expense of the periods in which they happen to be incurred.

Further, as some current research has shown, noteworthy declines in productivity often accompany the introduction of new process technology.[5] These productivity declines can last up to a year, even longer when a radical new technology like CIM is installed. Apparently, the new equipment introduces severe and unanticipated process disruptions, which lead to equipment breakdowns that are higher than expected; to operating, repair, and maintenance problems; to scheduling and coordination difficulties; to revised materials standards; and to old-fashioned confusion on the factory floor.

We do not yet know how much of the disruption is caused by inadequate planning. After investing considerable effort and anguish in the equipment acquisition decision, some companies no doubt revert to business as usual while waiting for the new equipment to arrive.

Whatever the cause, the productivity decline is particularly ill timed since it occurs just when a company is likely to conduct a postaudit on whether it is realizing the anticipated savings from the new equipment. Far from achieving anticipated savings, the postaudit will undoubtedly reveal lower output and higher costs than predicted.

Tangible benefits

The usual difficulties in carrying out DCF analysis – choosing an appropriate discount rate and evaluating correctly all relevant investment alternatives – apply with special force to the consideration of investments in CIM process technology. The greater flexibility of CIM technology, which allows it to be used for successive generations of products, gives it a longer useful life than traditional process investments. Because its benefits are likely to persist longer, overestimating the relevant discount rate will penalize CIM investments disproportionately more than shorter lived investments. The compounding effect of excessively high annual interest rates causes future cash flows to be discounted much too severely. Further, if executives arbitrarily specify short payback periods for new investments, the effect will be to curtail more CIM investments than traditional bottleneck-relief projects.

But beyond a longer useful life, CIM technology provides many additional benefits – better quality, greater flexibility, reduced inventory and floor space, lower throughput times, experience with new technology – that a typical capital justification process does not quantify. Financial analyses that focus too narrowly on easily quantified savings in labor, materials, or energy will miss important benefits from CIM technology.

Inventory savings

Some of these omissions can be easily remedied. The process flexibility, more orderly product flow, higher quality, and better scheduling that are typical of properly used CIM equipment will drastically cut both work-in-process (WIP) and finished goods inventory levels. This reduction in average inventory levels represents a large cash inflow at the time the new process equipment becomes operational. This, of course, is a cash savings that DCF analysis can easily capture.

Consider a product line for which the anticipated monthly cost of sales is $500,000. Using existing equipment and technology, the producing division carries about three months of sales in inventory. After investing in flexible automation, the division heads find that reduced waste, scrap, and rework, greater predictability, and faster throughput permit a two-thirds reduction in average inventory levels. (This is not an unrealistic assumption: Murata Machinery Ltd. has reported that its FMS installation permitted a two-thirds reduction in workers, a 450% increase in output, and a 75% cut in inventory levels.[6])

Pruning inventory from three months to one month of sales produces a cash inflow of $1 million in the first year the system becomes operational. If sales increase 10% per year, the company will enjoy increased cash flows from the inventory reductions in all future years too – that is, if the cost of sales rises to $550,000 in the next year, a two-month reduction

Example of an FMS justification analysis

With the following analysis, one U.S. manufacturer of air-handling equipment justified its investment in an FMS installation for producing a key component:

1
Internal manufacture of the component is essential for the division's long-term strategy to maintain its capability to design and manufacture a proprietary product.
2
The component has been manufactured on mostly conventional equipment – some numerically controlled – with an average age of 23 years. To manufacture a product in conformance with current quality specifications, the company must replace this equipment with new conventional equipment or advanced technology.
3
The alternatives are:
Conventional or numerically controlled stand-alone.
Transfer line.
Machining cells.
FMS.
4
FMS compares with conventional technology as Table A shows.
5
Intangible benefits include virtually unlimited flexibility for FMS to modify mix of component models to the exact requirements of the assembly department.
6
The financial analysis for a project life of ten years compares the FMS with conventional technology (static sales assumptions, constant, or base-year, dollars) as Table B shows.
7
With dynamic sales assumptions showing expected increases in production volume, the annual operating savings will double in future years and the financial yield (still using constant, base-year, dollars) will increase to more than 17% per year.

On the basis of this analysis and recognizing the value of the intangible item (5), which had not been incorporated formally, the company selected the FMS option.

Table A

	Conventional equipment	FMS
Utilization	30 %-40 %	80 %-90 %
Number of employees needed (including indirect workers, such as those who do materials handling, inspection, and rework)*	52	14
Reduced scrap and rework	–	$ 60,000 annually
Inventory	$ 2,000,000	$ 1,100,000†
Incremental investment	–	$ 9,200,000

*Each employee costs $36,000 a year in wages and fringe benefits.
†Inventory reductions because of shorter lead times and flexibility.

Table B

Year	Investment	Operating savings	Tax savings ITC and ACRS depreciation	After-tax cash flow 50 %
0	$ 9,200	$ 900‡	$ 920	$ –7,380
1		1,428§	1,311	1,370¶
2		1,428	1,923	1,675
3		1,428	1,835	1,632
4		1,428	1,835	1,632
5		1,428	1,835	1,632
6		1,428		714
7		1,428		714
8		1,428		714
9		1,428		714
10		1,428		714

After-tax yield: 11.1 %.
Payback period: during year 5.

‡$ 900 = Inventory reduction at start of project

§$ 1,428 = 38 fewer employees at $36,000/year + $60,000 scrap and rework savings.

¶$ 1,370 = (1,428) (1 – 0.50) + (1,311) (0.50).

in inventory saves an additional $100,000 that year, $110,000 the year after, and $121,000 the year after that.

Less floor space

CIM also cuts floor-space requirements. It takes fewer computer-controlled machines to do the same job as a larger number of conventional machines. Also, the factory floor will no longer be used to store inventory. Recall the example of the Japanese plant that installed a flexible manufacturing system and reduced space requirements from 103,000 to 30,000 square feet. These space savings are real, but conventional financial accounting systems do not measure their value well—especially if the building is almost fully depreciated or was purchased years before when price levels were lower. Do not, therefore, look to financial accounting systems for a good estimate of the cost or value of space. Instead, compute the estimate in terms of the opportunity cost of new space: either its square-foot rental value or the annualized cost of new construction.

Many companies that have installed CIM technology have discovered a new factory inside their old one. This new "factory within a factory" occupies the space where excessive WIP inventory and infrequently used special-purpose machines used to sit. Eliminating WIP inventory and rationalizing machine layout can easily lead to savings of more than 50% in floor space. In practice, these savings have enabled some companies to curtail plant and office expansion programs and, on occasion, to fold the operations of a second factory (which could then be sold off at current market prices) into the reorganized original factory.

Higher quality

Greatly improved quality, defined here as conformance to specifications, is a third tangible benefit from investment in CIM technology. Automated process equipment leads directly to more uniform production and, frequently, to an order-of-magnitude decline in defects. These benefits are easy to quantify and should be part of any cash flow analysis. Some managers have seen five- to tenfold reductions in waste, scrap, and rework when they replaced manual operations with automated equipment.

Further, as production uniformity increases, fewer inspection stations and fewer inspectors are required. If automatic gauging is included in the CIM installation, virtually all manual inspection of parts can be eliminated. Also, with 100% continuous automated inspection, out-of-tolerance parts are detected immediately. With manual systems, the entire lot of parts to be produced before a problem is detected would need to be reworked or scrapped.

These capabilities lead, in turn, to significant reductions in warranty expense. When General Electric automated its dishwasher operation, for example, its service call rate fell 50%. Designing manufacturability into products, making the production process more reliable and uniform, and improving automated inspection can all contribute to major cash flow savings. Although it may be hard to estimate these savings out to four or five significant digits, it would be grossly wrong to assume that the benefits are zero. We must overcome the preference of accountants for precision over accuracy, which causes them to ignore benefits they cannot quantify beyond one or two digits of accuracy.

We can estimate still other tangible benefits from CIM. John Shewchuk of General Electric claims that accounts receivable can be reduced by eliminating the incidence of customers who defer payment until quality problems are resolved.[7] Consider too that because improved materials flow can reduce the need for forklift trucks and operators, factories will enjoy a large cash flow saving from not having to acquire, maintain, repair, and operate so many trucks. All these calculations belong in a company's capital justification process.

Intangible benefits

Other benefits of CIM include increased flexibility, faster response to market shifts, and greatly reduced throughput and lead times. These benefits are as important as those just discussed but much harder to quantify. We may not be sure how many zeros should be in our benefits estimate (are they to be measured in thousands or millions of dollars?) much less which digit should be first. The difficulty arises in large part because these benefits represent revenue enhancements rather than cost savings. It is fairly easy to get a ballpark estimate for percentage reductions in costs already being incurred. It is much harder to quantify the magnitude of revenue enhancement expected from features that are not already in place.

Greater flexibility

The flexibility that CIM technology offers takes several forms. The benefits of economies of scope—that is, the potential for low-cost production

of high-variety, low-volume goods – are just beginning to flow from FMS environments as early adopters of the technology start to service after-market sales for discontinued models on the same equipment used to produce current high-volume models. We are also beginning to see some customized production on the same lines used for standard products.

Beyond these economy-of-scope applications, CIM's reprogramming capabilities make it possible for machines to serve as backups for each other. Even if a machine is dedicated to a narrow product line, it can still replace lost production during a second or a third shift when a similar piece of equipment, producing quite a different product, breaks down.

Further, by easily accommodating engineering change orders and product redesigns, CIM technology allows for product changes over time. And, if the mix of products demanded by the market changes, a CIM-based process can respond with no increase in costs. The body shop of one automobile assembly plant, for example, quickly adjusted its flexible, programmed spot-welding robots to a shift in consumer preference from the two-door to the four-door version of a certain car model. Had the line been equipped with nonprogrammable welding equipment, the adjustment would have been far more costly.

CIM's flexibility also gives it usefulness beyond the life cycle of the product for which it was purchased. True, in the short run, CIM may perform the same functions as less expensive, inflexible equipment. Many benefits of its flexibility will show up only over time. Therefore, it is difficult to estimate how much this flexibility will be worth. Nonetheless, as we shall see, even an order-of-magnitude estimate may be sufficient.

Shorter throughput & lead time

Another seemingly intangible benefit of CIM is the great reductions it makes possible in throughput and lead time. At the Yamazaki factory described at the beginning of this article, average processing time per work piece fell from 35 to 1.5 days. Other installations, including Yamazaki's Mazak plant in Florence, Kentucky, have reported similar savings, ranging from a low of 50% reduction in processing time to a maximum of nearly 95%. To be sure, some of the benefits from greatly reduced throughput times have already been incorporated in our estimate of savings from inventory reductions. But there is also a notable marketing advantage in being able to meet customer demands with shorter lead times and to respond quickly to changes in market demand.

Author's note: Especially helpful comments on the preliminary draft were made by Robin Cooper and Robert Hayes (Harvard Business School), Alan Kantrow (*Harvard Business Review*), George Kuper (Manufacturing Studies Board), and Scott Richard and Jeff Williams (Carnegie-Mellon).

Increased learning

Some investments in new process technology have important learning characteristics. Thus, even if calculations of the net present value of their cash flows turn up negative, the investments can still be quite valuable by permitting managers to gain experience with the technology, test the market for new products, and keep a close watch on major process advances.

These learning effects have characteristics similar to buying options in financial markets. Buying options may not at first seem like a favorable investment, but quite small initial outlays may yield huge benefits down the line. Similarly, were a company to invest in a risky CIM-related project, it could reap big gains should the technology provide unexpected competitive advantages in the future. Moreover, given the rapid pace of technological change and the advantages of being an early market participant, companies that defer process investments until the new technology is well established will find themselves far behind the market leaders. In this context, the decision to defer investment is often a decision not to be a principal player in the next round of product or process innovation.

The companies that in the mid-1970s invested in automatic and electronically controlled machine tools were well positioned to exploit the microprocessor-based revolution in capabilities – much higher performance at much lower cost – that hit during the early 1980s. Because operators, maintenance personnel, and process engineers were already comfortable with electronic technology, it was relatively simple to retrofit existing machines with powerful microelectronics. Companies that had earlier deferred investment in electronically controlled machine tools fell behind: they had acquired no option on these new process technologies.

The bottom line

Although intangible benefits may be difficult to quantify, there is no reason to value them at zero in a capital expenditure analysis. Zero is, after all, no less arbitrary than any other number. Conservative accountants who assign zero values to many intangible benefits prefer being precisely wrong to being vaguely right. Managers need not follow their example.

One way to combine difficult-to-measure benefits with those more easily quantified is, first, to estimate the annual cash flows about which there is the greatest confidence: the cost of the new process equipment and the benefits expected from labor, inventory, floor space, and cost-of-quality savings. If at this point a discounted cash flow analysis—done with a sensible discount rate and a consideration of all relevant alternatives—shows a CIM investment to have a positive net present value, well and good. Even without accounting for the value of intangible benefits, the analysis will have gotten the project over its financial hurdle. If the DCF is negative, however, then it becomes necessary to estimate how much the annual cash flows must increase before the investment does have a positive net present value.

To see how one manufacturer justified its investment in FMS, turn to the insert entitled "Example of an FMS Justification Analysis."

Suppose, for example, that an extra $100,000 per year over the life of the investment is sufficient to give the project the desired return. Then management can decide whether it expects heightened flexibility, reduced throughput and lead times, and faster market response to be worth at least $100,000 per year. Should the company be willing to pay $100,000 annually to enjoy these benefits? If so, it can accept the project with confidence. If, however, the additional cash flows needed to justify the investment turn out to be quite large—say $3 million per year—and management decides the intangible benefits of CIM are not worth that sum, then it is perfectly sensible to turn the investment down.

Rather than attempt to put a dollar tag on benefits that by their nature are difficult to quantify, managers should reverse the process and estimate first how large these benefits must be in order to justify the proposed investment. Senior executives can be expected to judge that improved flexibility, rapid customer service, market adaptability, and options on new process technology may be worth $300,000 to $500,000 per year but not, say, $1 million. This may not be exact mathematics, but it does help put a meaningful price on CIM's intangible benefits.

As manufacturers make critical decisions about whether to acquire CIM equipment, they must avoid claims that such investments have to be made on faith alone because financial analysis is too limiting. Successful process investments must yield returns in excess of the cost of capital invested. That is only common sense. Thus the challenge for managers is to improve their ability to estimate the costs and benefits of CIM, not to take the easy way out and discard the necessary discipline of financial analysis.

References

1 This example has appeared in several articles on strategic justification for flexible automation projects. Clifford Young of Arthur D. Little has traced the example to *American Market/Metalworking News*, October 26, 1981. Other examples of the labor, machinery, and throughput savings from flexible manufacturing system installations are presented in Anderson Ashburn and Joseph Jablonowski, "Japan's Builders Embrace FMS," *American Machinist*, February 1985, p. 83.

2 John P. Van Blois, "Economic Models: The Future of Robotic Justification," Thirteenth ISIR/Robots 7 Conference, April 17-21, 1983 (available from Society of Manufacturing Engineers, Dearborn, Michigan).

3 Robert H. Hayes and David A. Garvin, "Managing As If Tomorrow Mattered," HBR May-June 1982, p. 70.

4 Quoted in John Shewchuk, "Justifying Flexible Automation," *American Machinist*, October 1984, p. 93.

5 See Robert H. Hayes and Kim B. Clark, "Exploring the Sources of Productivity Differences at the Factory Level," in *The Uneasy Alliance: Managing the Productivity-Technology Dilemma*, ed. Kim B. Clark, Robert H. Hayes, and Christopher Lorenz (Boston: Harvard Business School Press, 1985), and Bruce Chew, "Productivity and Change: Understanding Productivity at the Factory Level," Harvard Business School Working Paper (1985).

6 "Japan's Builders Embrace FMS," *American Machinist*, February 1985, p. 83.

7 John Shewchuk, "Justifying Flexible Automation."

[See the Appendix on page 94.]

Appendix

Getting the numbers right

Part I
The cost of capital

A company always has the option of repurchasing its common shares or retiring its debt. Therefore, managers can estimate the cost of capital for a project by taking a weighted average of the current cost of equity and debt at the mix of capital financing typical in the industry. Extensive studies of the returns to investors in equity and fixed-income markets during the past 60 years show that from 1926 to 1984 the average total return (dividends plus price appreciation) from holding a diversified portfolio of common stocks was 11.7% per year. This return already includes the effects of rising price levels. Removing the effects of inflation puts the real (after-inflation) return from investments in common stocks at about 8.5% per year (see *Table A*).*

These historical estimates of 8.5% real (or about 12% nominal) are, however, overestimates of the total cost of capital. From 1926 to 1984, fixed-income securities averaged nominal before-tax returns of less than 5% per year. Taking out inflation reduces the real return (or cost) of high-grade corporate debt securities to about 1.5% per year. Even with recent increases in the real interest rate, a mixture of debt and equity financing produces a total real cost of capital of less than 8%.

Many corporate executives will, no doubt, be highly skeptical that their real cost of capital could be 8% or less. Their disbelief probably comes from making one of two conceptual errors, perhaps both. First, executives often attempt to estimate their current cost of capital by looking at their accounting return on investment – that is, the net income divided by the net invested capital – of their divisions or corporations. For many companies this figure can be in the 15% to 25% range.

There are several reasons, however, why an accounting ROI is a poor estimate of a company's real cost of capital. The accounting ROI figure is distorted by financial accounting conventions such as depreciation method and a variety of capitalization and expense decisions. The ROI figure is also distorted by management's failure to adjust both the net income and the invested capital figures for the effects of inflation, an omission that biases the accounting ROI well above the company's actual real return on investment.

The second conceptual error that makes an 8% real cost of capital sound too low is implicitly to compare it with today's market interest rates and returns on common stocks. These rates incorporate expectations of current and future inflation, but the 8.5% historical return on common stocks and the less than 2% return on fixed-income securities are *real* returns, after the effects of inflation have been netted out.

Now it is possible, of course, to do a DCF analysis by using nominal market returns as a way of estimating a company's cost of capital. In fact, this may even be desirable when you are doing an after-tax cash flow analysis since one of the important cash flows being discounted is the nominal tax depreciation shield from new investments. I have, however, seen many a company go seriously wrong by using a nominal discount rate (say in excess of 15%) while it was assuming level cash flows over the life of their investments.

Consider, for example, the data in *Table B*, which is excerpted from an actual capital authorization request. Notice that all the cash flows during the ten years of the project's expected life are expressed in 1977 dollars, even though the company used a 20% discount rate on the cash flows of the several investment alternatives. This assumption of a 20% cost of capital most likely arose from a prior assumption of a real cost of capital of about 10% and an expected inflation rate of 10% per year. But if it believed that inflation would average 10% annually over the life of the project, the company should also have raised the assumed selling price and the unit costs of labor, material, and overhead by their expected price increases over the life of the project.

It is inconsistent to assume a high rate of inflation for the interest rate used in a DCF calculation but a zero rate of price change when you are estimating future net cash flows from an investment. Naturally, this inconsistency – using double-digit discount rates but level cash flows – biases the analysis toward the rejection of new investments, especially those yielding benefits five to ten years into the future. Compounding excessively high interest rates will place a low value on cash flows in these later years: a 20% interest rate, for example, discounts $1.00 to $.40 in five years and to $.16 in ten years. If companies use discount rates derived from current market rates of return, then they must also estimate rates of price and cost changes for all future cash flows.

Table A **Annual return series 1926-1984**

Mean annual returns

Series	1926-1984	1950-1984	1975-1984
Common stocks	11.7%	12.8%	14.7%
Long-term corporate bonds	4.7	4.5	8.4
U.S. Treasury bills	3.4	5.1	9.0
Inflation (CPI)	3.2	4.4	7.4

Real annual returns net of inflation

Series	1926-1984	1950-1984	1975-1984
Common stocks	8.5%	8.4%	7.3%
Long-term corporate bonds	1.5	0.1	1.0
U.S. Treasury bills	0.2	0.6	1.6

Part II
Measuring alternatives

Look again at the capital authorization request in *Table B*. The cash flows from alternative 1 assume a constant level of sales during the next ten years; the cash flows from alternative 5 show a somewhat higher level of sales based on a small increase in market share. The difference in sales revenue as currently projected, however, is not all that great. Only if managers anticipate a steady decrease in market share and sales revenue for alternative 1, a decrease occasioned by domestic or international competitors adopting the new production technology, would alternative 5 show a major improvement over the status quo.

Obviously, not all investments in new process technology are investments that should be made. Even if competitors adopt new technology and profits erode over time, a company may still find that the benefits from investing would not compensate for its costs. But either way, the company should rest its decision on a correct reading of what is likely to happen to cash flows when it rejects a new technology investment.

Table B **Example of a capital authorization request***

Alternative 1	**Rebuild present machines**						
Year	**1977**	**1978**	**1979**	**1980**	**1981**	...	**1986**
Sales	$ 6,404	$ 6,404	$ 6,404	$ 6,404	$ 6,404	...	$ 6,404
Cost of sales:							
Labor	168	168	168	168	168	...	168
Material	312	312	312	312	312	...	312
Overhead	1,557	1,557	1,557	1,557	1,557	...	1,557
Alternative 5	**Purchase all new machines**						
Year	**1977**	**1978**	**1979**	**1980**	**1981**	...	**1986**
Sales	$ 6,404	$ 6,724	$ 7,060	$ 7,413	$ 7,784	...	$ 7,784
Cost of sales:							
Labor	167	154	148	152	152	...	152
Material	312	328	344	361	380	...	380
Overhead	1,557	1,440	1,390	1,423	1,423	...	1,423

*Adapted from Robert S. Kaplan and Glen Bingham, *Wilmington Tap and Die*, Case 185-124 (Boston: Harvard Business School, 1985).

Part III
Piecemeal investment

Each year, a company or a division may undertake a series of small improvements in its production process—to alleviate bottlenecks, to add capacity where needed, or to introduce islands of automation based on immediate and easily quantified labor savings. Each of these projects, taken by itself, may have a positive net present value. By investing on a piecemeal basis, however, the company or division will never get the full benefit of completely redesigning and rebuilding its plant. Yet the pressures to go forward on a piecemeal basis are nearly irresistible. At any point in time, there are many annual, incremental projects scattered about from which the investment has yet to be recovered. Thus, were management to scrap the plant, its past incremental investments would be shown to be incorrect.

One alternative to this piecemeal approach is to forecast the remaining technological life of the plant and then to enforce a policy of accepting no process improvements that will not be repaid within this period. Managers can treat the money that otherwise would have been invested as if it accrued interest at the company's cost of capital. At the end of the specified period, they could abandon the old facility and build a new one with the latest relevant technology.

Although none of the usual incremental process investments may have been incorrect, the collection of incremental decisions could have a lower net present value than the alternative of deferring most investment during a terminal period, earning interest on the unexpended funds, and then replacing the plant. Again, the failure to evaluate such global investment is not a limitation of DCF analysis. It is a failure of not applying DCF analysis to all the feasible alternatives to annual, incremental investment proposals.

*Roger G. Ibbotson and Rex A. Sinquefield, *Stocks, Bonds, Bills and Inflation: The Past and the Future* (Charlottesville, Va.: Financial Analysts Research Foundation, 1982).
The author has updated this study for returns earned during 1982-1984

This estimate should be adjusted up or down, depending on whether the project's risk is above or below the risk of the average project in the market. A detailed discussion of appropriate risk adjustments is beyond the scope of this article. Good treatments can be found in David W. Mullins, Jr., "Does the Capital Asset Pricing Model Work?" HBR January-February 1982, p. 105, and in chap. 7-9 in Richard Brealey and Stewart Myers, *Principles of Corporate Finance*, 2d ed. (New York: McGraw-Hill, 1984).

WHARTON REPROGRAPHICS

Accounting 102

Spring 1995

First Midterm Examination - Prof. Rajan

INSTRUCTIONS

1. Check to see that you have a total of 11 pages, including this one.
2. This is a closed book, closed notes exam. All books and other materials must be placed on the floor before the exam begins.
3. Make sure that there is at least one empty seat between you and the next student.
4. Calculators are allowed.
5. No questions will be answered during the exam. If you think a question is ambiguous, read it again, carefully. If you still feel some assumption is necessary, state an appropriate assumption explicitly and continue.
6. The exam ends in two hours.
7. Print your full name on this cover and your last name in the top right hand corner of each exam page.

NAME (PRINT): SOLUTIONS & GRADING KEY.

Circle your TA's Name and the Recitation you are registered for:

T.A Name	Recitation Time
Conner	9 a.m
Limaye	10 a.m
Vargus	11 a.m
	12 noon

RESULTS:

PART I	:	PART IV	:
PART II	:	PART V	:
PART III	:	PART VI	:
		PART VII	:
		TOTAL	=

PART I (10 Points) — 2 each.

1. If each furnace produced required a hose that costs $16, and 5000 furnaces are produced for the month, the $80,000 total cost for the month is considered to be

a. a direct fixed cost
b. a direct variable cost
c. a period cost
d. an indirect variable cost
e. an indirect fixed cost

B

2. For which of the following products or services would you most likely use process costing?

a. Custom-built houses
b. Boeing 767 jet aircraft
c. 20-inch television sets
d. Consulting assignments
e. Designer evening gowns

C

3. A factor used to systematically link an indirect cost to a cost object is called:

a. a cost pool
b. a cost allocation base
c. a cost tracer
d. a cost burden
e. a cost accumulation

B

4. Direct manufacturing costs total $70,000, conversion costs total $50,000, and indirect manufacturing costs total $90 per machine hour. If 300 machine hours were used, what is the total manufacturing cost?

a. $ 50,000
b. $ 74,000
c. $ 77,000
d. $ 93,000
e. $ 97,000

E

5. Which of the following statements about operations costing is **false** ?

a. Conversion cost journal entries are analogous to manufacturing overhead entries in process costing.
b. Conversion costs are allocated to WIP as units pass through the operation.
c. Conversion Costs and Conversion Costs Allocated are closed against each other.
d. Actual conversion costs are credited to the Conversion Costs account as they arise.
e. None of the above.

D

PART II (17 Points)

Murphy Inc. revealed the following information about its operations for the year 1994 (in '000s of dollars):

Opening Inventory		Closing Inventory	
Direct Materials	- $ 60;	Direct Materials	- $ 114;
Work-in-process	- $ 96;	Finished Goods	- $ 90.
Finished Goods	- $ 75.		

Sales Revenue	= $ 690;
Materials Purchased	= $ 420
Conversion Costs	= $ 495;
Prime Costs	= $ 636;
Gross Margin	= $ 105.

Required: Compute the following amounts for 1994 and provide them in the indicated spaces. Use the remainder of this page for your work.

a) Direct Materials Used — 366 (2)

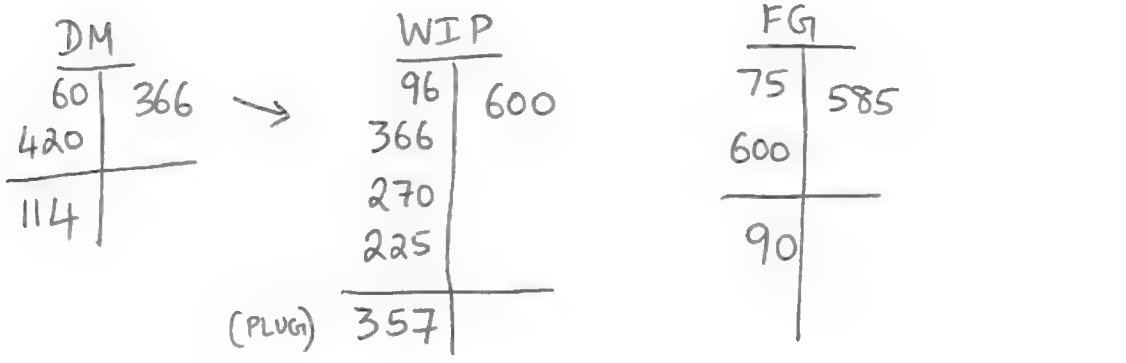
b) Factory Overhead Costs — 225 (4)

c) Total Manufacturing Costs incurred — 861 (3)

d) Cost of Goods Manufactured — 600 (2)

e) Cost of Goods Sold — 585 (3)

f) Closing WIP Inventory — 357 (3)



DM USED = 366, PRIME COSTS = 636 ⇒ DL = 636 (-) 366 = 270.

DL = 270, CC = 495 ⇒ FOH = 495 (-) 270 = 225.

PART III (7 points)

Straka Engineering is bidding on a prospective contract to build submarines for the Department of Defense. Straka estimates that completing the contract would involve direct labor costs of $70,000, direct material costs of $100,000, and other direct costs of $10,000. Straka generally uses a 250% markup rate on all direct costs for bidding, but, given the increased competition among contractors since the end of the Cold War, decides to reduce its bid by $60,000. Straka's budgeted overhead rate is 250% of direct labor costs.

Required :

1. (3 points) What is Straka's budgeted revenue from the submarine contract?

TOTAL DIRECT COST = 70 K + 100K + 10 K = 180 K (1)

∴ USUAL PRICE = (180 K)(250%) = 450 K (1)

∴ BDGTD REV = USUAL PRICE (-) BID REDUCTION
= 450 K (-) 60 K (1)
= 390,000.

2. (4 points) How much does Straka expect to add to its net income if it wins the bid?

EXP. COST = 180 K (DIRECT) + (70 K)(250%) (INDIRECT) (2)

= 180 K + 175 K = 355 K. (1)

∴ EXP. INC = BDGTD REV (-) EXP. COST
= 390 K (-) 355 K
= 35,000 (1)

LAST NAME: _____ 5

PART IV (12 points)

Hawgood manufactures automobile radios. Processing is generally initiated only when an order is received, and materials are purchased under a just-in-time system only as needed. For October, there were no beginning inventories of any kind. The following information is given for the month of October:

Standard materials cost per unit	- $40
Standard conversion cost per unit	- $32
Units produced	- 5,800
Number of finished units sold	- 5,600

Hawgood uses backflush costing with two trigger points - purchase of materials and sale of finished goods; overapplied or underapplied conversion costs are written off at the end of each month. Assume that standard costs and actual costs were the same with respect to both materials and conversion costs in October.

Required: 1. (10 points) Record journal entries for Hawgood's activities in October.

(2) 1. Materials purchase: Inventory A/c (RIP) 232 K (5800)($40)
A/P 232 K

(4) 2. Sale of goods: COGS 403,200
Inventory A/c 224,000
CCA 179,200

(2) 3. Actual CC: Conv Costs 185,600
Various A/cs. 185,600 (5800)($32)

(2) 4. Reconciliation: CCA 179,200
COGS 6,400
Conv Costs 185,600.

2. (2 points) What costs are represented in the ending balance of the inventory account?

Inventory A/c has $ 8,000 balance at the end, representing 200 unsold units valued at their

PART V (15 points)

Robitaille Manufacturing Co. makes customized vans. Robitaille employs a normal job-order system (with overhead applied using direct labor hours) and writes off under- or over-applied overhead to cost of goods sold each month. Robitaille started the month with no inventories at all. During the month, work was started on three vans, Vans 1, 2, and 3. The following information is given:

(a) Estimated manufacturing overhead for January 1994: $30,000

(b) Estimated direct-labor hours to be worked January 1994: 5,000 hours

(c) Materials purchased during January 1994: $400,000

(d) Materials placed into production in January 1994:

Van 1:	$100,000	
Van 2:	$ 50,000	
Van 3:	$ 75,000	$225,000

(e) Direct labor hours worked in January 1994:

Van 1:	1,800 hours	
Van 2:	2,400 hours	
Van 3:	1,800 hours	6,000 hours

(f) Actual manufacturing overhead incurred: $37,500

(g) Actual direct labor rate per hour: $10

(h) Van 1 was completed and transferred to finished goods but not sold at the end of the month.

(i) Van 2 was completed and sold during January 1994.

(j) Van 3 was not finished at the end of the month.

Required :

1. (2 points) What is the value of the direct materials inventory on January 31, 1994?

Matls purchased (-) Matls used

= 400 K (-) 225 K = 175,000. (2)

2. (3 points) Compute the overhead rate for January.

Ovhd rate = Estd. ovhd / Estd. base = $30K / 5K DLH = $6/DLH. (1) (1) (1)

3. (4 points) What is the value of the WIP inventory on January 31, 1994?

Only incomplete job is Van 3. (1)

Cost: Materials = 75,000. (1)

DL = (1,800 hrs)($10) = 18,000. (1)

Ovhd = (1,800 hrs)($6/DLH) = 10,800. (2)

103,800

4. (6 points) What is the cost of goods sold for January 1994?

Only goods sold is Van 2: (1)

Cost: Materials = 50,000 (1)

DL = (2,400 hrs)($10) = 24,000 (1)

Ovhd = (2,400)($6) = 14,400 (1)

88,400

Add: Underapplied overhead: (3)

Actual 37,500

(-) Applied 36,000 → 1,500

(6,000 TOTAL HRS)($6/DLH)

89,900

∴ COGS is 89,900.

PART VI (19 points)

The McEachern Company manufactures trophies in two departments. The trophies are stamped in Department A and immediately transferred and put into production for finishing in Department B. As of February 1, 1994, there were 4,000 units in opening inventory in Department B. The costs added in January to these units included Transferred-In Costs of $18,400, Direct Materials costs of $ 12,800 (representing 80% completion), and Conversion costs of $3,200 (40% complete).

In February, a further 58,000 units were transferred in from Department A at a cost of $284,200. As of February 28, 1994, there were 2,000 units still in process in Department B. These were 50% complete with respect to Direct Materials and 30% complete with respect to Conversion Costs.

The total costs incurred in Department B during February included Direct Materials costs of $ 231,200 and Conversion Costs of $ 118,000.

Required:

a. (3 points) On how many units was work both started and completed in Department 2 during February ?

Units completed = 58K + 4K − 2K = 60K — (2)

∴ Units started & completed = 60K − 4K — (1)

= 56K.

b. (6 points) If McEachern uses the FIFO method of accounting for inventory, compute the equivalent units of production in Department 2 for the relevant inputs.

	Work to finish OP WIP		Units Started & Completed		Work on End WIP	
Transferred-In Costs	0	+	56K	+	2K	= 58K.
Direct Materials	800	+	56K	+	1K	= 57,800.
CC	2,400	+	56K	+	600	= 59K.

LAST NAME: _____ 9

c. (10 points) Under the FIFO method, compute the cost of goods completed and transferred out of Department 2, and the cost of units in ending WIP, for February.

	T-I	DM	CC
CURRENT COSTS	284,200	231,200	118,000
EU	58,000	57,800	59,000
COST PER EU	$ 4.9	$ 4	$ 2

COST OF UNITS COMPLETED & T/O:

4K UNITS IN OP WIP: OP BAL - 34,400.

(3) (+) COST TO FINISH UNITS:
DM - 3,200 → (800)(4)
CC - 4,800 → (2,400)(2)
42,400

(2) 56 K UNITS STARTED & COMPLETED.
(56 K)(4.9 + 4 + 2) = 610,400.

∴ TOTAL COST = 652,800

(2) COST OF UNITS IN END WIP:
T-I - 9,800 → (2K)(4.9)
DM - 4,000 → (1K)(4)
CC - 1,200 → (600)(2)
15,000

PART VII (20 points)

The Sandstrom Company produces a single product. The company maintains an operations costing accounting system. The production process consists of three basic operations. In the first operation, raw material Alpha is stamped. In the second operation, this is assembled with a second raw material, Beta. The resulting product is finished in the final operation using a third material, Gamma.

Consulting studies have indicated that of the total time in direct labor hours to complete a finished unit, the stamping operation requires 40%, the assembly 50% and the finishing 10%. Factory overhead costs follow this same pattern as direct labor costs.

The following data are available as of February 1994 (the first month of operation):

Material Alpha purchased	$ 38,000
Material Beta purchased (12,000 pounds)	$ 12,000
Material Gamma used	$ 600
Total Conversion costs incurred	$ 30,000
Ending inventory - Alpha	$ 2,300
Ending inventory - Beta	$ 5,000
Units of product completed and transferred	12,000
Inventory in process at the end of the month:	
Units stamped but not assembled	3,000
Units assembled but not finished	2,000

Required:

a. (4 points) Compute the cost per equivalent unit with respect to conversion costs for the Sandstrom Company as a whole.

$$EU = 12K + (3K)(0.4) + (2K)(0.9)$$

$$= 15K \quad (3)$$

$$CC = 30K$$

$$\therefore \text{COST PER EU} = \frac{30K}{15K} = \$2. \quad (1)$$

LAST NAME: _____ 11

b. (6 points) Compute the cost per equivalent unit with respect to each of the three materials - Alpha, Beta and Gamma.

ALPHA: (38K (-) 2,300) / (12K + 3K + 2K) = 35,700 / 17,000 = $ 2·10 (1)

BETA: (12K (-) 5K) / (12K + 2K) = 7,000 / 14,000 = $ 0·50 (1)

GAMMA: 600 / 12K = $ 0·05 (1)

c. (3 points) What is the Cost of goods completed and transferred for Sandstrom Co.?

COST OF 12K UNITS:

(2) —— MATLS - (12K)(2·10 + 0·50 + 0·05) = 31,800

(1) —— CC - (12K)($2) = 24,000

55,800

d. (3 points) What is the Cost of goods stamped but not assembled?

COST OF 3K UNITS AT END OF 1ST OPERATION:

(1) —— MATLS - (3K)($2·1) = 6,300 (ONLY ALPHA COST)

(2) —— CC - (3K)(0·4)($2) = 2,400

8,700

e. (4 points) What is the Cost of goods assembled but not finished?

COST OF 2K UNITS AT END OF 2ND OPERATION

(2) —— MATLS - (2K)(2·1 + 0·5) = 5,200 (BOTH ALPHA & BETA)

(2) —— CC - (2K)(0·9)($2) = 3,600

Accounting 102

Spring 1995

Second Midterm Examination - Prof. Rajan

INSTRUCTIONS

1. Check to see that you have a total of 11 pages, including this one.
2. This is a closed book, closed notes exam. All books and other materials must be placed on the floor before the exam begins.
3. Make sure that there is at least one empty seat between you and the next student.
4. Calculators are allowed.
5. No questions will be answered during the exam. If you think a question is ambiguous, read it again, carefully. If you still feel some assumption is necessary, state an appropriate assumption explicitly and continue.
6. The exam ends in two hours.
7. Print your full name on this cover and your last name in the top right hand corner of each exam page.

NAME (PRINT): SOLUTIONS AND GRADING KEY

Circle your TA's Name and the Recitation you are registered for:

T.A Name	Recitation Time
Malcolm Conner	9 a.m
Vikram Limaye	10 a.m
Mark Vargus	11 a.m
	12 noon

RESULTS:				
	PART I	:	PART IV	:
	PART II	:	PART V	:
	PART III	:	PART VI	:
			PART VII	:
			TOTAL	=

LAST NAME: _____ 2

PART I (12 Points)

1. Combined Products has on hand some obsolete inventory that cost $ 50,000 and has a disposal value of $ 30,000. The inventory could be sold for $ 55,000 if reworked at an additional cost of $ 18,000. The incremental effect on operating income of a decision to rework the inventory would be:

a. a decrease of $ 3,000
b. a decrease of $ 7,000
c. an increase of $ 5,000
d. an increase of $ 7,000
e. an increase of $ 17,000

D

2. The allocation of variable costs of service departments should be determined by

a. multiplying budgeted units of usage by budgeted variable cost per unit.
b. multiplying budgeted units of usage by actual variable cost per unit.
c. multiplying actual units of usage by actual variable cost per unit.
d. multiplying actual units of usage by budgeted variable cost per unit.
e. multiplying budgeted units of usage by actual total cost per unit.

D

3. A company produces and sells two products - J and K - which have respective contribution margins of $4 and $6 per unit. Fixed costs are $70,000. If the planned sales mix is 2 units of J for each unit of K, the breakeven point involves:

10,000 units of J and 5,000 units of K.

4. (3 points) If a product's selling price and unit variable cost both increase 10%, and fixed costs do not change, then

a. the unit contribution margin increases and the contribution margin ratio is unchanged
b. both the unit contribution margin and the contribution margin ratio decrease
c. both the unit contribution margin and the contribution margin ratio are unchanged
d. the unit contribution margin increases and the contribution margin ratio decreases
e. none of the above

A

5. (3 points) Departments X and Y use a common facility whose fixed costs of operation are $100,000. If X alone used the facility, the facility's fixed costs would be $75,000. The service provided by the facility to X can be purchased externally for a fixed payment of $120,000, plus variable costs. Similarly, Department Y can buy the facility's services externally for a lump sum of $80,000, plus variable costs. Under the Stand-Alone Cost Allocation Method, how much in common costs would be allocated to Department X?

a. $25,000
b. $40,000
c. $60,000
d. $75,000
e. $80,000

C

PART II (7 Points)

For the month of June, Wregget Corporation projected sales of $ 250,000, variable costs of $ 100,000, fixed costs of $ 100,000 and after-tax income of $ 32,500.

Required: a. (2 Points) What is the tax rate faced by Wregget Corporation?

PRE-TAX INCOME = 50 K.

$\therefore$ TAX RATE = $\frac{50K - 32,500}{50K} = 35\%$ — 2

2. (5 Points) What is the amount of sales (in dollars) needed in June to achieve a revised after-tax income target of $ 42,250 ?

PRE-TAX TARGET = $\frac{42,250}{0.65} = 65,000$ — (1)

CMR = $1 - \frac{100K}{250K} = \frac{3}{5} = 0.6$ — (2)

$\therefore$ DESIRED SALES $ = $\frac{FC + TARGET}{CMR}$ — (1)

$= \frac{100K + 65,000}{0.6}$

$= \underline{\underline{275,000}}$ — (1)

LAST NAME: _____ 4

PART III (12 Points)

The following information relates to Andrusak Co., which processes a main product and a by-product from a common process:

Total manufacturing costs of main product and byproduct	$ 33,000
Total sales of main product	- $ 37,500
Estimated net realizable value of byproduct produced (including ending inventory of byproduct)	- $ 3,000

The ending inventory of the main product constitutes 25% of its production volume.
The ending inventory of the byproduct constitutes 10% of its production volume.
There are no beginning inventories.
Andrusak treats byproduct revenue as a reduction of manufacturing costs.

Required: a. (9 points) If Andrusak recognizes byproducts when **sold**, what is the firm's gross margin ? What are the ending inventories of the main product and byproduct?

Sales of Main product = 37,500.

COGS: Total Mfg cost = 33,000 — (2)
(-) By product Revenue = 2,700
Total Net cost = 30,300 — (1)

Since 75% of main product was sold,
COGS = (75%)(30,300) = 22,725 — (2)

∴ GM = 37,500 (-) 22,725 — (1)
= 14,775

End Inv: Main = (25%)(30,300) = 7,575 — (2)
By product = 0. — (1)

b. (3 points) If Andrusak recognizes byproducts when **produced**, what is the gross margin ?

New COGS = 22,725 (-) End by product Inv
= 22,725 (-) 300 = 22,425 — (2)

GM = 37,500 (-) 22,425
= 15,075 — (1)

PART IV (18 Points)

The following data are from the records of Young Company:

		Factory Service Departments			Production Departments	
		A	B	C	X	Y
Budgeted factory overhead before allocation (in '000 $)		560	744	483	320	260
Estimated hours of service provided to other departments by:	Dept. A	—	100	200	400	300
	Dept. B	150	—	100	350	350
	Dept. C	—	100	—	600	300

Required: a. (4 points) Use the direct method to compute the service department costs allocated to the production departments.

	X	Y
Budg. ovhd	320	260
(2) — Allocate A (560 as 4:3)	320	240
(1) — Allocate B (744 as 1:1)	372	372
(1) — Allocate C (483 as 2:1)	322	161
	1,334	1,033

b. (3 points) Based on your answer to (a), how much overhead would be allocated to a job that spends 100 hours in Dept. X, if X's budgeted allocation base is 26,680 machine hours ?

(1)

Bdgtd rate = $\frac{\text{Estd ovhd}}{\text{Estd base}} = \frac{1,334\ K}{26,680} = \$50/\text{MHR}$

(1)

Allocated cost = (50)(100) = $5,000

(1)

c. (5 points) Write down the equations to determine the reciprocated costs of A, B and C.
(You don't have to compute the reciprocated costs themselves)

(1) —— $A = 560 + \frac{3}{19} B$

(2) —— $B = 744 + \frac{1}{10} A + \frac{1}{10} C$

(3) —— $C = 483 + \frac{1}{5} A + \frac{2}{19} B$

d. (6 points) Use the step-down method to compute the budgeted factory overhead allocated to the production departments.

A: Gives $\frac{3}{10} = 0.3$ to B & C

B: Gives $\frac{5}{19} = 0.26$ to A & C.

C: Gives $\frac{1}{10} = 0.10$ to A & B.

(2)

∴ Allocate in order A, B, C.

(2) Allocate A (560 as 1:2:4:3)

(1) Allocate B (800 as 2:7:7)

Allocate C (695 as 2:1)

(1)

	A	B	C	X	Y
	560	744	483	320	260
Allocate A	(560)	56	112	224	168
	0	800	595	544	428
Allocate B		(800)	100	350	350
		0	695	894	778
Allocate C			(695)	463.33	231.67
				1,357,333	1,009,667

LAST NAME: _____ 7

PART V (20 points)

Tubbo Manufacturing Co. buys zeon for $ 0.80 a gallon. At the end of processing in Department 1, zeon splits off into Products A, B and C. Product A is sold at the split-off point. Products B and C must be processed further before they can be sold; Product B is processed in Department 2 and Product C is processed in Department 3. Following is a summary of costs and other related data for the year ended June 30, 1994:

	Department 1	2	3
Cost of zeon	$ 96,000	$ -0-	$ -0-
Direct Labor	14,000	45,000	65,000
Manufacturing Overhead	10,000	21,000	49,000
Total	$ 120,000	66,000	114,000

	Products A	B	C
Gallons Sold	20,000	30,000	45,000
Gallons on hand at June 30, 1994	10,000	—	15,000
Sales	$ 30,000	$ 96,000	$ 141,750

All gallons on hand at June 30, 1994 were fully processed. There were no opening inventories of any kind. There was also no zeon on hand at June 30, 1994.

Required: 1. (2 points) What is the joint cost to be allocated to the three products ?

$ 120 K —— (2)

2. (3 points) If the sales value at split-off method were to be used to allocate joint costs, what value would you use for Product A ?

(1) —— $\frac{\$ 30\ K}{20\ K} \times 30\ K = \$ 45,000$ —— (1)

3. (4 points) Compute the estimated net realizable value for the three products.

(1) —— A = $ 45 K.

(1) —— B = 96 K (-) 66K = $ 30 K.

(2) —— C = $(141,750) \times \frac{60\ K}{45\ K}$ (-) 114 K = $ 75 K.

4. (4 points) If the estimated net realizable value method were used, compute the cost of Product B sold during the year ended June 30, 1994.

(2) —— Seperable cost = 66 K

(2) —— Joint cost = $(120\,K)\left(\frac{30K}{150K}\right) = 24\,K$

90 K

5. (3 points) If the estimated net realizable value method were used, compute the cost of ending inventory for Product A.

(1) —— Seperable cost = 0

(1) —— Joint cost = $(120\,K)\left(\frac{45K}{150K}\right) = 36\,K$

36 K

Cost of end inv = $\frac{10\,K}{30\,K} \times 36\,K = 12\,K$

(1)

6. (4 points) If the constant gross margin percentage method were used to allocate joint costs, what is the gross margin percentage you would charge to each product ?

GM = $ENRV_A + ENRV_B + ENRV_C$ (-) Joint costs

= 150 K (-) 120 K = 30 K —— (1)

Final Sales = 45 K + 96 K + 189 K

= 330 K —— (2)

∴ GM % = $\frac{30\,K}{330\,K}$ = 9.09 %

(1)

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PART VI (18 points)

Marty Industries, which manufactures and sells summer lotions and insect repellents, is planning to diversify by introducing a new winter product. The product (called Chap-Off) is a lip balm that will be sold in a lipstick-type tube. The product will be sold to wholesalers in boxes of 24 tubes for $8 per box. Because of available capacity, no additional fixed overhead costs will be incurred to produce the product. However, a $90,000 charge for fixed overhead will be absorbed by the product to "allocate a fair share" of the company's present fixed overhead costs to the new product.

Using the estimated sales and production of 100,000 boxes of Chap-Off as the expected volume, the accounting department has developed the following costs *per box*:

Direct material	$3.60
Direct labor	2.00
Total manufacturing overhead	1.40
Total cost	$7.00

The costs above include costs for producing both the lip balm and the tube into which the lip balm is to be placed.

As an alternative to making the tubes, Marty has approached a cosmetics manufacturer to discuss the possibility of purchasing the tubes for Chap-Off. The purchase price of the empty tubes from the cosmetics manufacturer would be $1.35 per box of 24 tubes. If Marty accepts the purchase proposal, it is predicted that direct labor and variable overhead costs per box of Chap-Off would be reduced by 10 percent, and that direct materials costs would be reduced by 25 percent.

Required: 1. (7 points) Should the company make or buy the tubes?

VAR. OVHD PER BOX = $1.40 - \frac{90,000}{100,000} = 0.50$ (1)

TOTAL VC OF PRODN = $3.60 + 2.00 + 0.50 = 6.10$ PER BOX. (1)

VC PER BOX OF PURCHASING:

DM = $(3.6)(0.75) = 2.70$

DL = $(2.00)(0.9) = 1.80$ (1)

VOH = $(0.50)(90\%) = 0.45$

TUBES = 1.35 (2)

6.30 PER BOX. (1)

∴ MAKE SINCE $0.20 PER BOX CHEAPER. (1)

LAST NAME: _____ 10

2. (3 points) What would be the *maximum* purchase price for the tubes that would be acceptable to Marty Industries?

NEED $6.10 = 2.70 + 1.80 + 0.45 + \text{TUBE PRICE}$ — (2)

$\Rightarrow$ MAX TUBE PRICE = 1.15 PER Box. — (1)

3. (4 points) Instead of sales of 100,000 boxes, revised estimates show sales volume at 120,000 boxes. At this new volume, *additional* equipment must be acquired to manufacture the tubes. The annual rental rate for the new equipment is $40,000. Assuming that the outside supplier will not accept an order for less than 100,000 boxes, should Marty Industries make or buy the tubes?

COST OF MAKING: $(120\text{K})(6.10) + 40\text{K} = 772\text{K}$. — (2)

COST OF BUYING: $(120\text{K})(6.30) = 756\text{K}$ — (1)

$\therefore$ BUY AS IT SAVES 16K PER YEAR. — (1)

4. (4 points) Refer to the data in part (3). Assume that the outside supplier will accept an order of *any* size for the tubes at $1.35 per box. How, if at all, would this change your answer?

(3) SHOULD MAKE 100K UNITS AND BUY 20K UNITS.

TOTAL COST = $(100\text{K})(6.10) + (20\text{K})(6.30)$

(1) $= 736\text{K}$,

WHICH IS BETTER THAN EITHER OF THE ALTERNATIVES FROM PART (3).

PART VII (13 points)

Stevens Machine Co. operated at its break-even sales volume of $2,250,000 during 1994, a year in which it incurred fixed costs of $900,000. For 1995, Stevens is considering eliminating some specialized machinery. This will reduce fixed costs by $200,000 annually. Doing so will, however, reduce the quality of the product and lead Stevens to cut unit selling prices by 10%. Stevens does not expect any change in the number of units sold.

Required:

a. (3 points) What is the total contribution margin made by Stevens in 1994?

BREAK-EVEN ⇒ TOTAL CONTRIB. MARGIN = FIXED COSTS

∴ CONTRIB. MARGIN = 900,000 (3)

b. (7 points) What would be the breakeven sales level if the machinery were eliminated?

CURRENT VC = 2,250,000 − 900,000 = 1,350,000 (1)

P ↓ 10%, X SAME ⇒ NEW SALES $ = (90%)(2,250,000)
= 2,025,000 (2)

∴ NEW VCR = $\frac{1,350,000}{2,025,000} = \frac{2}{3}$ (2)

∴ NEW CMR = $1 - \frac{2}{3} = \frac{1}{3}$ NEW FC = 700,000 (1)

∴ NEW B.E = $\frac{\text{NEW FC}}{\text{NEW CMR}} = \frac{700\text{ K}}{1/3} = 2,100,000$. (1)

(1)

c. (3 points) Should the company eliminate the machinery? Why or why not?

NO. BY DOING NOTHING, THEY BREAK-EVEN NEXT YEAR.
BY ELIMINATING MACHINERY, THEY ONLY HAVE SALES OF 2,025 K WHILE THEY NEED 2,100 K TO BREAK EVEN, i.e., THEY LOSE MONEY.

(2)

Accounting 102
Spring 1995
Final Examination - Prof. Rajan

INSTRUCTIONS

1. Check to see that you have a total of 11 pages, including this one.
2. This is a closed book, closed notes exam. All books and other materials must be placed on the floor before the exam begins.
3. Calculators are permitted.
4. No questions will be answered during the exam. If you think a question is ambiguous, read it again, carefully. If you still feel some assumption is necessary, state an appropriate assumption explicitly and continue.
5. The exam ends in two hours.
6. Print your full name on this cover and your last name in the top right hand corner of each exam page.

NAME (PRINT): SOLUTIONS

Circle your TA's Name and the Recitation you are registered for:

Circle your TA's Name and the Recitation you are registered for:

T.A Name	Recitation Time
Malcolm Conner	9 a.m
Vikram Limaye	10 a.m
Mark Vargus	11 a.m
	12 noon

RESULTS:

PART I	:	PART IV	:
PART II	:	PART V	:
PART III	:	PART VI	:

TOTAL =

PART I (12 Points)

1. Clemon Company has budgeted the following unit sales for the second quarter of 1995: April - 7,000; May - 12,000; and June - 10,500. Clemon's policy is to maintain an ending inventory of 8 percent of sales of the following month. Total units to be produced in April are:

a. 6,600
b. 7,000
c. 7,400
d. 7,960
e. None of the above

C

2. Tsay Electronics is considering buying an automated soldering machine which costs $500,000. It requires working capital of $50,000, which will be recovered at the end of the project's life of five years. Annual cash savings are anticipated to be $206,000. The machine is depreciated on a straight-line basis, and has a terminal salvage value of $20,000.

a) The average annual accounting income from the project is: $ 110,000

b) When computing the accrual accounting rate of return based on initial investment, the "initial investment" value you would use is:

$ 550,000

b) When computing the accrual accounting rate of return based on average investment, the "average investment" value you would use is:

$ 310,000

3. Trinity Bookstores budgeted direct labor costs of $ 240,000 for a 6,000-unit level. Actual cost was $ 190,000 for a 5,000-unit level. These data indicate a

a. $10,000 Unfavorable Sales Volume Variance.
b. $50,000 Favorable Static Budget Variance.
c. $10,000 Unfavorable Sales Volume Variance.
d. $10,000 Unfavorable Flexible Budget Variance.
e. $10,000 Favorable Production Volume Variance.

B

PART II (10 Points)

The Toccoa Division of National Products is planning its 1994 operating budget. Average operating assets of $ 3,000,000 will be used during the year and unit selling prices are expected to average $95 each. Variable costs of the division are budgeted at $40 per unit, while fixed costs are set at $500,000. The company's required rate of return is 18 percent, and the company has a budgeted ROI of 20 percent.

Required: 1. (5 points) What is the division's budgeted volume for 1994 ?

Let X = budgeted volume.

$$\frac{X(95-40)-500,000}{3,000,000} = \frac{20}{100}$$

$$\Rightarrow 55X - 500,000 = 600,000$$

$$\Rightarrow 55X = 1,100,000$$

$$\Rightarrow X = 20,000$$

2. (5 points) The division manager receives a bonus of 25 percent of the residual income. What is his anticipated bonus for 1994 ?

Expected RI $= 20,000(95-40) - 500,000 - \left(\frac{18}{100}\right)(3,000,000)$

$= 60,000$

$\therefore$ Expected bonus $= (25\%)(60,000) = 15,000$.

PART II (13 Points)

The Pittsburgh Pens Company is considering buying a special purpose machine for $125,000. The machine has a useful life of 8 years, and can be disposed of for $10,000 after that time. If the machine were sold after just one year of use, it would fetch $84,000; its disposal price after each subsequent year is reduced by $12,000. The company, which has a required rate of return of 9%, anticipates annual cash savings of $35,000 due to the machine.

The following information may assist you in some of the computations required below.

Present Value of $1 at 9% at the end of:

Year 1 - 0.92	Year 2 - 0.84	Year 3 - 0.77	Year 4 - 0.71
Year 5 - 0.65	Year 6 - 0.60	Year 7 - 0.55	Year 8 - 0.50

Present Value of an Annuity of $1 at 9% for 8 years - 5.54

Required: Compute the following items (rounded off to two decimal points), and provide the solutions in the spaces provided. Use the rest of the page for your computations.

IGNORE

a) ~~(3 Points) Bailout Payback Period~~ 1.26 Years

b) (3 Points) Payback Period 3.57 Years

c) (3 Points) Breakeven Time 4.51 Years

d) (4 Points) Lowest level of annual cash savings such that the firm would still accept the project (using NPV) $ 21,660.65

[FOR ANSWER OF 22,563 GIVE 1 POINT].

PART IV (21 points)

Raiborn Co., which makes chicken peelers, uses a standard absorption costing system. It applies overhead using direct labor hours as the application base. The following information pertains to Raiborn's operations in 1994, its first year of operation:

Static Budget Units	40,000
Units Produced	42,000
Budgeted Fixed Overhead	$ 160,000
Budgeted Variable Overhead	$ 238,000
Actual Fixed Overhead	$ 159,120
Actual Variable Overhead	$ 248,880

	Direct Materials	Direct Labor
Standard inputs per peeler	5 pounds	0.50 hours
Standard price of inputs	$ 1.65 per pound	$ 14 per hour
Input quantities used	204,000 pounds	21,400 hours
Incurred costs	$ 377,400	$ 280,000

Raiborn had 3,000 pounds of direct materials in inventory on December 31, 1994.

Required: Compute the following items and indicate your answers in the spaces provided. For each variance, indicate whether it is favorable (F) or unfavorable (U).
Use the following page for your computations.

a) (3 Points) Materials Price Variance $ 41,400 U
(FOR ANSWER OF 40,800 U GIVE 2 POINTS)

b) (3 Points) Materials Usage Variance $ 9,900 F

c) (3 Points) Direct Labor Efficiency Variance $ 5,600 U

d) (3 Points) Variable Overhead Spending Variance $ 5,780 F

e) (3 Points) Variable Overhead Applied $ 249,900

f) (3 Points) Fixed Overhead Flexible Budget Variance $ 8,880 F

g) (3 Points) Fixed Overhead Production Volume Variance $ 8,000 F

PART V (24 points)

Janus Corporation has several operating divisions which are run as profit centers. The Hi-Fi division manufactures and sells speakers. Its budgeted income statement for 1995, at an anticipated sale level of 20,000 units, is given below.

	Per Unit	Total ('000)
Sales Revenue	$300	$6,000
Manufacturing Costs		
Woofer	80	1,600
Other Variable Costs	70	1,400
Fixed Costs	40	800
Total Manufcg Costs	190	3,800
Gross Margin	110	2,200
Marketing Costs:		
Variable	15	300
Fixed Marketing	20	400
Total Mktg Costs	35	700
Operating Income	75	1,500

The Hi-Fi Division currently buys woofers from an outside supplier. The Woofer Division of Janus itself manufactures and sells 35,000 woofers to outside customers at a unit price of $120. The Woofer Division has the capacity to make 50,000 woofers. It has unit variable manufacturing costs of $50 and unit variable marketing costs of $4 per woofer. Its fixed manufacturing costs are $500,000.

The Hi-Fi Division manager approaches the Woofer Division manager with a proposal to purchase woofers internally. The Woofer Division would incur variable manufacturing costs of $45 per woofer to make the woofers the Hi-Fi Division requires. Further, the Woofer Division would not incur any variable marketing costs if it supplied the woofers internally to the Hi-Fi Division.

Required:

1. (5 points) The Hi-Fi Division proposes to buy 20,000 woofers from the Woofer Division at a total price of $1,200,000. Will the Woofer Division manager accept this proposal?

If Accept:

Contbn on order = (60-45) × 20 K = $ 300 K

(−) Lost contbn on 5,000 units diverted from market

= (120-54) × 5,000 = $ 330 K.

∴ Lose 30 K if Accept.

So, Reject.

2. (5 points) From the viewpoint of the company as a whole, how many woofers should be sold (a) to outsiders and (b) to the Hi-Fi Division?

By diverting woofer for internal use when it could be sold outside, company saves (80-45) = $35 per speaker.
However, give up (120-54) = $66 per woofer in contn.
∴ Optimal to sell as much externally as possible, and fill up capacity with internal sales.
ie, 35K to outsiders
15K inside to Hi-Fi division.

3. (7 points) For what range of transfer prices will the managers of the Woofer Division and the Hi-Fi division agree to implement the "optimal" manufacturing and selling plan identified in your answer to the previous question?

Woofer division: To emphasize outsiders first but still fill up capacity internally, need
$TP \in [45, 111]$.
Hi-Fi : Will buy internally if $TP \in [0, 80]$.
∴ Optimal $TP \in [45, 80]$.

4. (4 points) Suppose that the Woofer Division is located in a state that imposes a 10% tax on income earned within its boundaries, while the Hi-Fi Division is located in a state with no income tax.
Ignoring issues of incentives or coordination, what transfer price would be chosen by Janus Corporation to minimize tax payments for the company as a whole?

(Assume that only transfer prices that are greater than or equal to unit manufacturing absorption costs and less than or equal to the market price of "substantially similar" woofers are acceptable to the taxing authorities).

Want to minimize profits in Woofer, so set TP as low as possible.

∴ TP = Full absorption mfg cost

$= 45 + \frac{\$500K}{50K \text{ units}} = \$55.$

5. (3 points) Suppose Janus Corporation announces the transfer price computed in the previous question to price all transfers between the Woofer Division and Hi-Fi Division. If each manager then acts autonomously to maximize his divisional profit, will they achieve the optimal production and sourcing plans identified in question 2? Why or why not?

Yes.

TP of \$55 is in the optimal range [45, 80].

∴ Tax-minimizing transfer price also achieves goal congruence.

LAST NAME: _____ 10

PART VI (20 Points)

The vice-president for Huber Corporation has received the following income statement for November 1994. The statement was prepared using standard variable costing. Standard unit costs are held constant through each calendar year. Under- or over-applications of costs are written off to cost of goods sold at the end of each month.

	Sales Revenue	$ 2,400,000
(Less)	Variable Standard COGS	1,200,000
	Contribution Margin	1,200,000
(Less)	Fixed Manufacturing Costs	600,000
(Less)	Fixed S,G & A Costs	400,000
	Net Income Before Taxes	200,000

The controller has attached the following notes to the statement:

1. There were no fixed manufacturing cost spending variances, and no variable cost variances of any kind.
2. The unit sales price for November averaged $24.
3. The standard unit rate for fixed manufacturing costs is determined using a normal monthly production of 150,000 units.
4. Finished Goods inventory was 35,000 units on November 1, 1994, and 80,000 units on November 30, 1994.

Required: 1. (3 points) How many units did the firm produce in November?

$$\text{Units sold} = \frac{2,400,000}{24} = 100,000$$

$$\text{Units produced} = 100,000 + 80,000 - 35,000$$

$$= 145,000.$$

2. (4 points) Under a standard absorption system, what would have been the firm's cost of goods sold at standard (i.e., prior to adjusting for variances) ?

$$\text{Fixed mfg rate} = \frac{600,000}{150,000} = \$ 4/\text{unit}.$$

$$\text{VC per unit} = \frac{1,200,000}{100,000} = \$ 12/\text{unit}$$

$\therefore$ Abs. cost = $ 16 / unit

COGS at std. = 16 x 100 = $ 1,600,000.

3. (5 points) Compute the firm's production volume variance for November under a standard absorption system.

Budgeted FOH = 600,000

Applied = (145,000)($4/unit) = 580,000

∴ PVV = 20,000 U.

4. (4 points) Compute the firm's net income under a standard absorption system.

Sales Rev =	2,400,000
(-) COGS at std =	1,600,000
(-) PVV =	20,000
GM	780,000
(-) Fixed S,G,&A	400,000
NI	380,000

5. (4 points) Reconcile and explain the difference between the firm's variable-costing and absorption-costing figures.

NI is 180,000 higher under absorption.

Corresponds to fact that 45K units more were produced than sold.

Alternatively, End FG inv (-) Beg FG inv
= 80K (-) 35K = 45K.

Each unit has $4 in FOH attached.

6

WHARTON REPROGRAPHICS

Accounting 102

Spring 1993

First Midterm Examination - Prof. Rajan

INSTRUCTIONS

1. Check to see that you have a total of 11 pages, including this one.
2. This is a closed book, closed notes exam. All books and other materials must be placed on the floor before the exam begins.
3. Make sure that there is at least one empty seat between you and the next student.
4. Calculators are allowed, but alpha-numeric calculators are not permitted.
5. No questions will be answered during the exam. If you think a question is ambiguous, read it again, carefully. If you still feel some assumption is necessary, state an appropriate assumption explicitly and continue.
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7. Print your full name on this cover and your last name in the top right hand corner of each exam page.

NAME (PRINT): SOLUTIONS AND GRADING KEY

Circle your TA's Name and the Recitation you are registered for:

T.A Name	Recitation Time
Dequer	9 a.m
Pomeroy	10 a.m
Seivright	11 a.m
	12 noon

RESULTS:

PART I	:	PART IV	:
PART II	:	PART V	:
PART III	:	PART VI	:

TOTAL =

PART I (17 Points)

1. (2 points) The operating statement of an appliance maker indicated $ 120,000 of direct labor, $ 90,000 of factory overhead, $ 45,000 advertising, $ 75,000 of direct materials used, and $ 30,000 of sales commissions. If the total of the prime costs listed above were added to the total of the conversion costs listed above, the sum would be

a. $ 285,000
b. $ 450,000
c. $ 405,000
d. $ 360,000
e. None of the above

C

2. (2 points) Of the following industries, the one most likely to utilize job-order costing is

a. Shipbuilding
b. Steel-making
c. Automobile
d. Chemical
e. Oil Refining

A

3. (2 points) If power is metered to the assembly department and the cost object is each individual automobile assembled, the classification of power costs would be:

a. variable cost and direct cost
b. variable cost and indirect cost
c. fixed cost and direct cost
d. fixed cost and indirect cost
e. semi-fixed cost and direct cost

B

4. (2 points) For a manufacturing company, an example of a period cost is:

a. depreciation on plant equipment
b. overtime premium paid to laborers
c. factory rent
d. insurance on production machinery
e. none of the above

E

5. (3 points) Of the following, which one is <u>not</u> a feature of Toyota's operations in Georgetown, Kentucky ?

a. Workers are encouraged to signal defects by pulling a cord.
b. Each worker has multiple jobs, including maintenance, setup and cleaning.
c. Suppliers are rewarded for shipping extra parts or staying ahead of schedule.
d. In order to keep batches of parts or partially-completed automobiles to a small number, machines stop often.
e. None of the above

C

6. (3 points) Ulf Corp. reported the following operating data for a year:

Manufacturing costs incurred:	$ 400,000
Increase in inventory of WIP	30,000
Decrease in inventory of finished goods	50,000

The cost of goods sold for the year is:

a. $ 320,000
b. $ 380,000
c. $ 420,000
d. $ 480,000
e. Cannot be determined from the information given.

C

7. (3 points) An audit firm uses a normal pricing markup on jobs that is 300% of direct professional labor and an overhead application rate that is 125% of direct professional labor. Budgeted operating income on a particular job is $ 42,000.

The budgeted amount of direct professional labor costs on this job is:

a. $ 24,000
b. $ 31,500
c. $ 42,000
d. $ 56,000
e. $ 73,500

D

Rev = 3X
X + 1.25 X = 42,000

PART II (6 Points)

Kjell Company uses job-order costing. Factory overhead is applied continuously to production at a predetermined rate of 150 percent of direct-labor cost. Any over or underapplied overhead is closed to cost of goods sold at the end of the month. The following information is available for the month of February:

1. Job 101 was the only job in process at January 31, with accumulated costs as follows:

Direct Materials	$ 4,000
Direct Labor	2,000
Applied Overhead	3,000
	$ 9,000

2. Jobs 102, 103, and 104 were started during February.

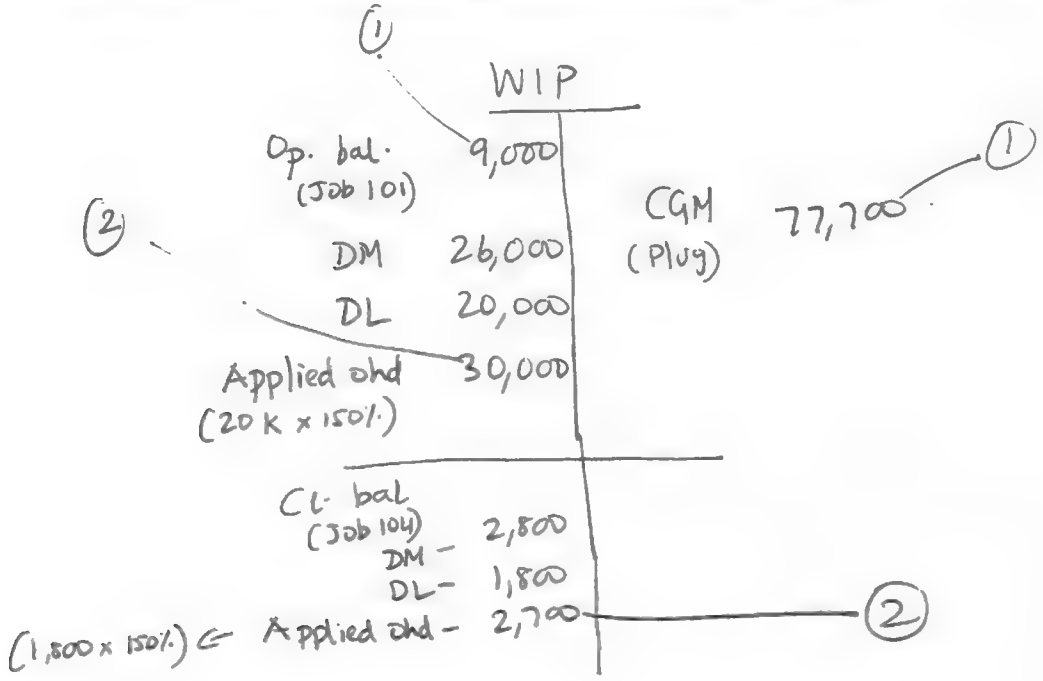
3. Total direct materials requisitions for February totaled $26,000.

4. Total direct labor cost of $20,000 was incurred in February.

5. Actual factory overhead was $32,000 in February.

6. The only job still in process at February 28 was Job 104, which has been responsible for $2,800 in direct materials costs and $1,800 in direct labor costs so far.

Required: Calculate the cost of goods manufactured for February.



LAST NAME: _____ 5

PART III (13 Points)

Jaromir Inc. builds speakers in a two-stage process. Cabinets are produced in Department 1 and the electronic components are then added in Department 2. In Department 2, Conversion Costs are applied uniformly throughout the production process. In addition, two basic materials are used in Department 2 - Drivers are added at the 50% stage of the production process and Crossovers are added at the end of the process. The following data is given for Department 2 for July:

Beginning inventory - 4,000 units (at the 25% stage of the production process)
Ending inventory - 2,000 units (at the 80% stage of the production process)
Transferred into process during the month - 50,000 units

Required: a. (3 points) How many units were started and completed in Dept. 2 during July ?

Completed = 4,000 + 50,000 − 2,000 = 52,000 — (1)

Started and Completed = Completed (-) Op Inv
= 52,000 (-) 4,000
= 48,000 — (2)

b. (5 points) If Jaromir uses the Weighted Average method of accounting for inventory, compute the equivalent units of production in Department 2 for all four relevant inputs.

	(1) Units completed and transferred	+	Work on Ending WIP	(1)
Drivers	52 K	+	2K	= 54 K
Crossovers	52 K	+	0	= 52 K (1)
Transferred-In Costs	52 K	+	2 K	= 54 K
Conversion Costs	52 K	+	1,600	= 53,600

(1) (1)

c. (5 points) If Jaromir uses the FIFO method of accounting for inventory, compute the equivalent units of production in Department 2 for all four relevant inputs.

	(1) Work done to finish Op WIP	+	Units started and completed	+	Work on End WIP	
Drivers	4K (1)	+	48 K	+	2K	= 54 K
Crossovers	4K	+	48 K	+	0	= 52 K
Transferred-In Costs	(1) 0	+	48 K	+	2K	= 50 K
Conversion Costs	3 K	+	48 K	+	1,600	= 52,600

PART IV (16 points)

K-San Department of the K-G Company uses FIFO Costing. The department had opening inventory of 1,000 units, which were 80% complete as to direct materials (at a cost of $ 1,400) and 30% complete as to conversion costs (at a cost of $ 2,250). During the year, 11,000 units were completed and transferred out. Closing inventory was 900 units, 40% complete as to direct materials and 20% complete as to conversion costs. Equivalent unit costs for the year were $ 2 for direct materials and $ 8 for conversion costs.

Required:

1. (2 points) What is the number of units on which production was started during the year ?

OI + Units started = T/o + EI

1,000 + Units started = 11,000 + 900

∴ Units started = 10,900 — (2)

2. (3 points) What is the dollar amount of direct material costs incurred during the year ?

EU of work for DM:

Work to finish op WIP = 200

Units started & completed = 10,000

Work on end WIP = 360

10,560 — (2)

Cost per EU = $ 2

∴ Total cost = (10,560)(2) = $ 21,120 — (1)

3. (3 points) What is the dollar amount of conversion costs incurred during the year ?

EU of work for CC:

Work to finish op WIP = 700

Units started & completed = 10,000

Work on end WIP = 180

10,880 — (2)

Cost per EU = $ 8

∴ Total cost = (10,880)(8) = $ 87,040 — (1)

LAST NAME: _____ 7

4. (5 points) What is the total cost of units completed and transferred out during the year ?

a) 1,000 units in Op WIP:

Op bal: DM 1,400 ①
CC 2,250

+ Cost of work to finish:

(200 × 2) DM 400 ①
(700 × 8) CC 5,600 ①

9,650

b) 10,000 units started & completed: ①

(10,000) (2+8) 100,000

109,650 ①

5. (3 points) What is the dollar value of the ending work-in-process inventory ?

Materials cost = (360)($2) = $ 720 ①

CC cost = (180)(8) = $ 1,440 ①

Total = $ 2,160 ①

LAST NAME: _____ 8

PART V (28 points)

The Mario Corp. uses a job-order costing system. The firm expects that total factory overhead for 1992 will be $ 300,000. In addition, it estimates that about 25,000 machine hours will be used in 1992. The following information is provided for 1992:

	Direct materials	WIP	Finished Goods
Opening balance	$ 20,000	$ 12,500	$ 11,000
Closing balance	$ 15,000	$ 22,000	$ 7,200

During 1992, direct materials costing $ 40,000 were purchased. Mario applies overhead using machine hours as the application base.

Required :

1. The following transactions summarize Mario's activities in 1992. Record the journal entry for each one of them in the space provided.

a) Factory direct labor costs incurred - $ 85,000 (17,000 hours @ $ 5 per hour).

(3) WIP 85,000
Payroll Liability 85,000

b) Factory Supervisor's Salary - $ 50,000.

(3) FOC 50,000
Payroll Liability 50,000

c) Raw materials placed into production.

(3) WIP 45,000
Materials 45,000

d) Machine power charges - $ 130,000 (20,000 hours @ $ 6.50 per hour)

(3) FOC 130,000
Accounts Payable 130,000

LAST NAME: _____ 9

e) Depreciation - $ 70,000

(3) FOC 70,000
Accumulated Depr. 70,000

f) Salesmen's Commissions paid in cash - $ 12,250

(2) Selling, Genl and Administrative Exp. 12,250
Cash 12,250

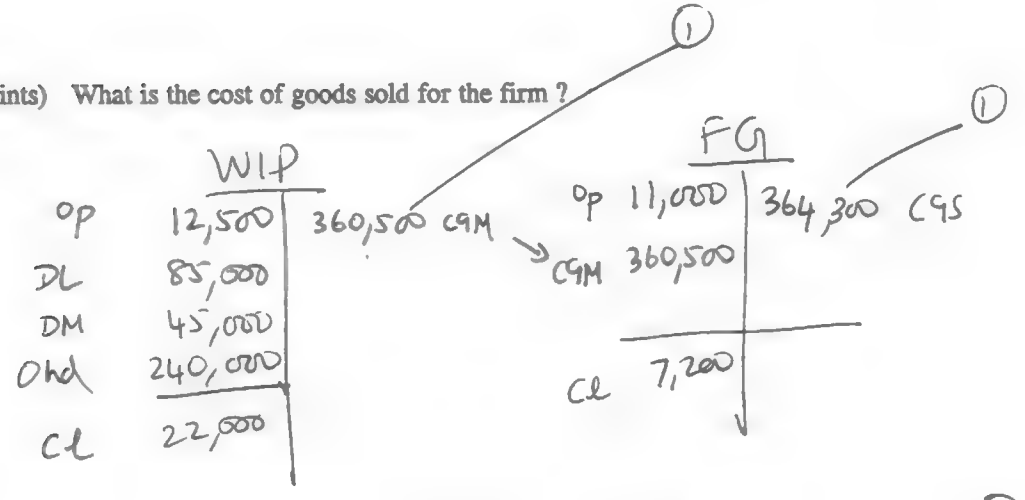
g) Application of overhead.

(4) WIP 240,000
FOA 240,000
($\frac{300,000}{25,000}$ x 20,000 hrs)

h) Year-end reconciliation of overhead accounts.

(3) FOA 240,000
COGS 10,000
FOC 250,000

2. (4 points) What is the cost of goods sold for the firm ?



COGS = 364,300 + 10,000 = 374,300 (2)

LAST NAME: _____ 10

PART VI (20 points)

Needham Inc. makes computer disk drives. For November, there were no beginning inventories of raw materials and no beginning or ending WIP. Needham uses a JIT production system and backflush costing. The November standard cost per unit is: direct materials $ 26, conversion costs $ 15. The following data pertain to November manufacturing:

Raw materials and components purchased	-	$ 10,600
Conversion Costs incurred	-	$ 6,160
Number of finished units manufactured	-	400
Number of finished units sold	-	384

Needham writes off overapplied or underapplied conversion costs at the end of each month. Assume that there are no material variances.

Required :

1. (12 points) Suppose that Needham's backflush system employs two trigger points: (i) purchase of raw materials and components and (ii) completion of finished goods. Prepare summary journal entries for November for Needham.

(Hint: There should be 5 journal entries).

	1. RIP	10,600		
(2)	——— Accounts Payable.		10,600	
	2. Finished Goods	16,400		
(3)	——— RIP		10,400	(400 x 26)
	Conv Costs Applied		6,000	(400 x 15)
	3. COGS	15,744		
(2)	——— Finished Goods		15,744	(384 x 41)
	4. Conversion Costs	6,160		
(2)	——— Various Accounts		6,160	
	5. Conv Costs Applied	6,000		
(3)	——— Cost of Goods Sold	160		
	Conversion Costs		6,160.	

LAST NAME: _____ 11

2. (8 points) Suppose that the backflush system's first trigger point is purchase of raw materials, as before, but the second is the sale of finished goods.

(i) What journal entry would be made at the time of purchase of raw materials ?

(2)

Inventory 10,600
Accounts Payable 10,600

(ii) What journal entry would be made at the time of sale of finished goods ?

(3)

Cost of Goods Sold 15,744
Inventory 9,984 (384 x 26)
Conversion Costs Applied 5,760 (384 x 15)

(iii) With specific reference to the details of this problem, briefly explain why this product costing method violates financial accounting theory.

(2) The Inventory closing balance is 10,600 (-) 9,984, or 616. This comprises $ 200 in unused materials and $ 416 (16 units @ $ 26) of finished goods.

(1) This violates financial accounting theory because the finished goods are inventoried only based on their materials component, i.e., conversion costs have been treated as period costs and not inventoried, which is wrong.

Accounting 102

Spring 1993

Second Midterm Examination - Prof. Rajan

INSTRUCTIONS

1. Check to see that you have a total of 12 pages, including this one.
2. This is a closed book, closed notes exam. All books and other materials must be placed on the floor before the exam begins.
3. Make sure that there is at least one empty seat between you and the next student.
4. Calculators are allowed.
5. No questions will be answered during the exam. If you think a question is ambiguous, read it again, carefully. If you still feel some assumption is necessary, state an appropriate assumption explicitly and continue.
6. The exam ends in two hours.
7. Print your full name on this cover and your last name in the top right hand corner of each exam page.

NAME (PRINT): SOLUTIONS AND GRADING KEY

Circle your TA's Name and the Recitation you are registered for:

T.A Name	Recitation Time
Dequer	9 a.m
Pomeroy	10 a.m
Seivright	11 a.m
	12 noon

RESULTS:				
	PART I	:	PART IV	:
	PART II	:	PART V	:
	PART III	:	PART VI	:
			PART VII	:
			TOTAL	=

PART I (24 Points)

1. (3 points) Service Department R renders 30% of its services to Service Department M, 50% to Production Department P, and 20% to Production Department Q. If R's total cost before allocation is $ 21,000, how much would be allocated to Q by the direct method ?

a. $ 4,200
b. $ 6,000
c. $ 10,500
d. $ 14,000
e. $ 15,000

B

2. (3 points) The distinction between joint products and byproducts is largely influenced by

a. federal income tax regulations
b. the relative number of products produced or sold
c. the relative costs incurred after the split-off point
d. the relative sales value of the products produced or sold
e. none of the above

D

3. (3 points) A company has a product line with a contribution margin of $ 17,000 and allocated fixed costs of $ 32,000, of which $ 14,000 cannot be eliminated. The net effect on the company's operating income of discontinuing this product line would be:

a. increase in operating income of $ 1,000
b. decrease in operating income of $ 1,000
c. increase in operating income of $ 15,000
d. decrease in operating income of $ 13,000
e. decrease in operating income of $ 15,000

A

4. (3 points) Which of the following statements about Activity Based Costing is not true ?

a. ABC traces costs from resources to activities, and then from activities to products.
b. Indirect cost application bases in ABC are often non-financial variables.
c. Companies with a diverse set of operating activities and diverse range of products are more likely to benefit from activity-based accounting.
d. ABC attempts to rectify the tendency of conventional accounting systems to overcost low-volume products and undercost high-volume products.
e. Activity based accounting can be used in conjunction with any form of product costing.

D

5. (6 points) A firm has one central facility and two production departments (M and N) that use it. The budgeted costs of operating the facility were fixed costs of $ 2,500 and variable costs of $ 2 per hour. Actual costs were $ 2,000 (fixed) and $ 1.50 per hour (variable). M and N budgeted to use the facility for 600 and 400 hours, respectively. They actually used it for 500 hours and 300 hours, respectively.

a) Under a single-rate approach, the total cost allocated to Department M would be:

a. $ 1,350
b. $ 2,000
c. $ 2,250
d. $ 2,500
e. none of the above

C

a) Under a dual-rate approach, the total cost allocated to Department N would be:

a. $ 1,250
b. $ 1,450
c. $ 2.250
d. $ 2,500
e. none of the above

E

6. (3 points) In 1992, Scotty Engine Co. operated at its breakeven sales volume of $ 975,000, while incurring fixed costs of $ 625,000. What was Scotty's total contribution margin generated in 1992 ?

a. $ 350,000
b. $ 625,000
c. $ 975,000
d. $ 1,600,000
e. Cannot be determined from the information given.

B

7. (3 points) A firm has a current contribution margin ratio of 0.40. Next year, the firm expects that it will have to reduce its selling price per unit by 10%, but that its costs will be unchanged. The firm's contribution margin ratio next year will be:

a. 0.30
b. 0.33
c. 0.36
d. 0.40
e. 0.44

B

LAST NAME: _____ 4

PART II (8 Points)

Big Jim's Accounting Emporium provides two types of services: tax and financial accounting. In efforts to generate revenue, Big Jim's relies heavily on radio and billboard advertising. Information on Big Jim's projected operations for 1993 follows:

	Taxes	Financial Accounting
Projected Revenues	$ 360,000	$ 200,000
Projected Variable Material costs	12,000	16,000
Projected Variable other costs	240,000	120,000
Projected Allocated fixed costs	$ 100,000	$ 200,000

Billable hours, which drive both costs and revenues, are projected at 12,000 hours for the Tax service department and 8,000 hours for the Financial Accounting department for 1993.

Required: a. (4 points) If $ 1 spent on advertising could increase either tax services billable time by one hour or financial accounting services billable time by one hour, on which service should the advertising dollar be spent ?

Tax: CM = 360K − 12K − 240K = 108 K

∴ CM per hour = $\frac{108\,K}{12\,K}$ = $ 9

Financial: CM = 200K − 16K − 120K = 64 K

∴ CM per hour = $\frac{64\,K}{8K}$ = $ 8

∴ Choose Tax.

b. (4 points) If $ 1 spent on advertising could increase either tax services revenue by $ 20 or financial accounting services revenue by $ 20 (with corresponding increases in costs), on which service should the advertising dollar be spent ?

Tax: CMR = $\frac{108\,K}{360\,K}$ = 30%

Financial: CMR = $\frac{64\,K}{200\,K}$ = 32%

∴ Choose Financial

(OR) Tax ⇒ $ 6 in CM,

Financial ⇒ $ 6.4 in CM.

LAST NAME: _____ 5

PART III (17 Points)

Big Mac Food Co. processes assorted animal parts into two main products - Burgs and Dogs. In May, Big Mac bought 100 lbs of parts (at $ 3 per lb). It processed them in its giant vat (at a cost of $ 180), to yield 50 lbs of unrefined Burgs and 30 lbs of unrefined Dogs, respectively.

The entire amount of unrefined Burgs was refined in Department B, at a cost of $ 600. During May, 40 lbs of Burgs were sold at a price of $ 30 per lb. Of the Dogs, 20 lbs were refined in Department D (at a cost of $ 300), and were sold at $ 25 per lb.

10 lbs of Burgs and 10 lbs of unrefined Dogs remained in inventory on May 31.

Required: a. (7 points) If joint costs were allocated under the physical measure method, what would be the gross margin for Burgs and Dogs, respectively, in the month of May ?

Joint Cost = $ 480

Allocation is 50:30 ie; $\frac{5}{8} \times 480 = \$ 300$ for Burgs

$\frac{3}{8} \times 480 = \$ 180$ for Dogs.

2

	Burgs	Dogs
Unit Joint Cost:	$\frac{300}{50} = \$ 6$	$\frac{180}{30} = \$ 6$
Unit Sepble Cost:	$\frac{600}{50} = \$ 12$	$\frac{300}{20} = \$ 15$
Unit Cost	$ 18	$ 21

2

1

	Burgs	Dogs
Sales Revenue	1,200	500
(-) COGS	720	420
Gross Margin	480	80

(20 Lbs)($ 21)

(40 Lbs)($ 18)

1

1

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b. (4 points) Under the estimated net realizable value method, how would the joint costs of the firm be allocated between Burgs and Dogs ?

ENRV: Burgs: $(50 \text{ lbs})(\$30) - \$600 = \$900$

Dogs: $(30 \text{ lbs})(\$25) - (30 \text{ lbs})\left(\frac{\$300}{20 \text{ lbs}}\right) = \$300$

∴ Allocate 3 : 1

i.e., $\frac{3}{4} \times 480 = \$360$ for Burgs

$\frac{1}{4} \times 480 = \$120$ for Dogs.

c. (6 points) If Big Mac were to use the constant gross-margin percentage method, how would it allocate the joint costs between Burgs and Dogs ?

Final GM = $ENRV_{Burgs} + ENRV_{Dogs} - Jt\ costs$ 1

$= 900 + 300 - 480 =$ (\$720.)

Final Sales = $(50 \text{ lbs})(\$30) + (30 \text{ lbs})(\$25) =$ (\$2,250) 1

∴ GM % = $\frac{720}{2,250} =$ (32%.) ⟹ 1 POINT

	Burgs	Dogs	
Final Sales	1,500	750	
(-) GM (32%)	(480)	240	1
Final COGS	1,020	510	1
Final Separable costs	(600)	450	1
Joint Costs	420	60	

LAST NAME: _____ 7

PART IV (14 points)

Francis Inc. has a manufacturing plant with three service departments (A, B and C) and a single production department (D). Following are the hours of service (measured in direct labor hours) expected to be provided by A, B and C for this year.

	Estimated Service Provided To			
	Dept. A	Dept. B	Dept. C	Dept. D
Estimated Service Provided By:				
Service Dept. A	—	750	750	1,500
Service Dept. B	600	—	1,200	200
Service Dept. C	1200	1800	—	1,000

The budgeted factory overhead before allocation comes to $ 8,500 for A, $ 15,000 for B, $ 7,500 for C and $ 9,000 for D.

Required: 1. (6 points) Carry out the step-down method of allocating the service department costs. (Show all the steps; Round off all allocations to the nearest integer).

Proportion to other service depts:

A: $\frac{1,500}{3,000} = 50\%$

B: $\frac{1,800}{2,000} = 90\%$

C: $\frac{3,000}{4,000} = 75\%$

∴ Order is B, C, A.

	A	B	C	D
	8,500	15,000	7,500	9,000
Allocate B (15,000 as 3:6:1)	4,500	−15,000	9,000	1,500
	13,000	0	16,500	10,500
Allocate C (16,500 as 6:5)	9,000		−16,500	7,500
	22,000		0	18,000
Allocate A	−22,000			22,000
	0			40,000

IF ALLOCATION ORDER IS WRONG, TAKE OFF 3 POINTS.

LAST NAME: _____ 8

2. (4 points) Write down the "reciprocated cost" equations to reflect the inter-dependencies among the various service departments.

$$C_A = 8,500 + 0.3\,C_B + 0.3\,C_C$$

$$C_B = 15,000 + 0.25\,C_A + 0.45\,C_C$$

$$C_C = 7,500 + 0.25\,C_A + 0.6\,C_B$$

3. (4 points) Suppose that Francis employs the reciprocal method of allocation. Also suppose that the production department (D) expects to use 8,000 machine hours during the year. If Job X actually uses up 500 machine hours, how much in overhead is allocated to the job ?

As D is the only production dept, any allocation method will result in D having a total overhead of $8,500 + 15,000 + 7,500 + 9,000 = \$40,000$.

$\therefore$ Ohd rate $= \frac{40,000}{8,000 \text{ hrs}} = \$5/\text{hr}$.

$\therefore$ Job allocation $= (\$5/\text{hr})(500 \text{ mch hrs}) = \$2,500$.

IF SOMEONE COULDN'T FIGURE OUT D'S OVERHEAD BUT HAS THE CORRECT METHOD FOR FINDING THE ALLOCATION TO JOB X, GIVE 2 POINTS

LAST NAME: _____ 9

PART V (16 points)

The following data relate to the three products of Tippett Company.

	A	B	C
Selling Price per unit	$ 15.0	$ 25.0	$ 12.5
Variable Cost per unit	$ 9.0	$ 17.5	$ 8.0
Contbn Margin per unit	$ 6.0	$ 7.5	$ 4.5

The company is currently selling 75,000, 30,000 and 45,000 units of products A, B and C respectively. The company has fixed costs of $ 201,825. The tax rate is 40%.

Required :

1. (3 points) What is the company's current Net Income after taxes ?

N.I after tax = 60% [(75K)($6) + (30K)($7.5) + (45K)($4.5) − 201,825]

= $ 405,405.

2. (6 points) Under the current product mix, how many dollars of total sales must the company achieve in order to break-even ?

"Package Sale" = 5A, 2B, 3C

Contrbn per package = (5)(6) + (2)(7.5) + (3)(4.5) = $ 58.50

∴ Packages to break even = $\frac{\$ 201,825}{58.50}$ = 3,450.

∴ Total sales to break even:

A: (3,450)(5)($ 15) = 258,750

B: (3,450)(2)($ 25) = 172,500

C: (3,450)(3)($ 12.5) = 129,375

560,625

LAST NAME: _____ 10

3. (3 points) In terms of total units, what is Tippett's current margin of safety ?

Total breakeven units = (3,450)(10) = 34,500. — 1

Current total units = 75K + 30K + 45K = 150,000 — 1

∴ Margin of Safety = 150,000 (-) 34,500 — 1

= 115,500.

4. (4 points) Under the current product mix, how many units of product B must Tippett sell in order to reach a total target Net Income after tax of $ 150,930 ?

After tax $ 150,930 ⇒ Before tax $\frac{150,930}{0.6}$ = $251,550 — 1

# of packages to hit target = $\frac{251,550 + 201,825}{58.50}$

= 7,750 — 2

∴ Units of B = (7,750)(2) = 15,500. — 1

==========

PART VI (2 Points)

Who was the former Wharton student who gave the presentation in class on the implementation of an activity-based costing system in his company ?

a. Bill Beaver of Air Products
b. Jeff King of Rhone Poulenc
c. Joel Demski of Martin Marietta
d. Tom Richard of Quaker Chemical
e. John Hand of Allied Signal

D

PART VII (19 points)

Seco Corp, a wholesale supply company, engages independent sales agents to market the company's lines. These agents currently receive a commission of 20 percent of sales, but they are demanding an increase to 25 percent of sales for the year ending December 31, 1994. Seco had already prepared its 1994 budget before learning of the agents' demand for an increase in commissions. The budgeted income statement is as follows:

Sales Revenues		$ 10,000,000
Variable Cost of Sales		6,000,000
Gross Margin		$ 4,000,000
Selling and Administrative Costs		
Commissions	2,000,000	
Other Costs (Fixed)	100,000	2,100,000
Operating Income		$ 1,900,000

Seco is considering the possibility of employing its own salespersons. Three individuals would be required, at an estimated annual salary of $ 30,000 each, plus commissions of 5 percent of sales for each. In addition, a sales manager would be employed at a fixed annual salary of $ 160,000. All other fixed costs, as well as the variable cost percentages, would remain the same as the estimates in the budgeted income statement.

Required: 1. (4 points) Based on the budgeted income statement for 1994, compute Seco's estimated breakeven point in sales dollars.

$$VCR = \frac{6m + 2m}{10m} = 0.8 \quad (2)$$

$$\therefore CMR = 1 - VCR = 0.2 \quad (1)$$

$$\therefore BE = \frac{FC}{CMR} = \frac{100{,}000}{0.2} = \$\,500{,}000 \quad (1)$$

2. (5 points) Compute Seco's estimated breakeven point in sales dollars for 1994 if the company employs its own salespersons. (Use next page also, if needed)

$$VCR = 0.6 + (0.05)(3) = 0.75$$

$$\therefore CMR = 0.25$$

$$FC = 100K + 90K + 160K = 350K$$

$$\therefore BE = \frac{350K}{} = \$\,1{,}400{,}000.$$

LAST NAME: _____ 12

3. (5 points) Suppose Seco continues to use the independent sales agents and agrees to their demand for a 25 percent sales commission. What volume (in sales dollars) would be required for 1994 to yield the same operating income as projected in the budgeted income statement ?

New CMR = 0·15

Need 1,900,000 + 100,000 = \$2 m in contbn

$\therefore$ Sales = $\frac{2,000,000}{0.15}$ = \$ 13,333,333

4. (5 points) What volume (in sales dollars) for 1994 would generate an identical operating income for 1994 regardless of whether Seco employs its own salespersons or continues to use the independent sales agents and pays them a 25 percent commission ?

Let x = Sales \$.

With own salespersons, $0.25x - 350K$

With sales agents, $0.15x - 100K$

$\therefore$ $0.25x - 350K = 0.15x - 100K$

$\Rightarrow$ $x = 2,500,000$.

FOR $x = 1,250,000$, GIVE FULL CREDIT.

Accounting 102

Spring 1993

Final Examination - Profs. Rajan and Topiol

INSTRUCTIONS

1. Check to see that you have a total of 12 pages, including this one.
2. This is a closed book, closed notes exam. All books and other materials must be placed on the floor before the exam begins.
3. Calculators are permitted.
4. No questions will be answered during the exam. If you think a question is ambiguous, read it again, carefully. If you still feel some assumption is necessary, state an appropriate assumption explicitly and continue.
5. The exam ends in two hours.
6. Print your full name on this cover and your last name in the top right hand corner of each exam page.

NAME (PRINT): SOLUTIONS AND GRADING KEY

Circle your TA's Name and the Recitation you are registered for:

Prof. Rajan:		Prof. Topiol
	9 a.m	
Dequer	10 a.m	Adiel
Pomeroy	11 a.m	Freudenthaler
Seivright	12 noon	Vasanth

RESULTS: PART I : DNEP PART IV : RON / PAUL

PART II : [redacted]DNE P PART V : K.R.

PART III : DAVE S PART VI : SUZANNE.

TOTAL =

LAST NAME: _____ 2

PART I (10 Points)

1. Typically, the first budget prepared is the

   a. Production Budget
   b. Sales Budget
   c. Cash Budget
   d. Capital Expenditure Budget
   e. Materials Budget

B

2. A normal absorption costing system provides for charging WIP with:

   a. actual direct labor costs and actual factory overhead costs
   b. actual direct labor costs and applied factory overhead costs
   c. applied direct labor costs and actual factory overhead costs
   d. applied direct labor costs and applied factory overhead costs

B

3. The cost of idle capacity is reflected by:

   a. an unfavorable spending variance
   b. an unfavorable efficiency variance
   c. an unfavorable production-volume variance
   d. an unfavorable budget variance
   e. all of the above

C

4. The most widely used method of determining transfer prices is

   a. Cost-based prices
   b. Market-based prices
   c. Negotiated prices
   d. Dual prices
   e. Arbitrated prices

A

5. When the denominator level of activity (or expected level of the application base) is less than the standard hours allowed, there must be

   a. an unfavorable production-volume variance
   b. a favorable flexible budget variance
   c. an unfavorable efficiency variance
   d. a favorable production-volume variance
   e. underapplication of overhead

D

PART II (15 Points)

1. Stapleton Company's static budget shows $ 180,000 of direct labor cost for the production of 20,000 units, but the actual direct labor cost was $ 170,000 for the production of 18,000 units. Under a flexible budget approach, the flexible budget variance would be:

a. $ 8,000 Favorable
b. $ 10,000 Favorable
c. $ 10,000 Unfavorable
d. $ 18,000 Favorable
e. $ 8,000 Unfavorable

E

2. Ramsey, Inc. forecasts $ 260,000 of sales for the third quarter. Its gross margin rate is 30% of sales, and its June 30 inventory is $ 60,000. Assume that the target inventory at September 30 is $ 80,000. Compute the budgeted purchases for the third quarter:

a. $ 162,000
b. $ 180,000
c. $ 202,000
d. $ 220,000
e. None of the above

C

3. The following selected data pertain to a division of Ulf Co.:

Sales = $ 2,000,000; Operating Income = $ 100,000;
Investment Turnover = 4 times; Imputed Interest Rate = 18 %.

The division's return on investment is:

a. 4.5 %
b. 5.0 %
c. 18 %
d. 20 %
e. None of the above

D

4. A project requires an initial investment of $ 450,000 in depreciable assets, with a useful life of 8 years and terminal disposal value of $ 50,000. Depreciation is based on the straight-line method. Predicted annual cash savings are $ 85,000. The project's accrual accounting rate of return on the average investment is:

a. 7.8 %
b. 14.0 %
c. 17.5 %
d. 34.0 %
e. None of the above

B

5. A company's static budget shows $ 80,000 of direct material cost for the production of 16,000 units. Actual direct material cost was $ 83,000 for the production of 17,000 units. This indicates:

a. Unfavorable flexible budget variance of $ 2,000
b. Favorable flexible budget variance of $ 3,000
c. Unfavorable sales volume variance of $ 3,000
d. Unfavorable sales volume variance of $ 5,000
e. None of the above

PART III (20 points)

Three Rivers Co. manufactures bracelets using thin strips of plastic. The production operation is a simple one, requiring only one material and very little labor. Variable overhead is applied on a machine hour (MH) basis. Fixed overhead is applied on a per-unit basis; the predetermined rate was calculated using a production estimate of 75,000 bracelets per month. The following standard costs and quantities have been developed for one bracelet:

Direct Material	(8 inches of plastic @ $ 0.01 per inch)	- $ 0.08
Direct Labor	(1 minute @ $ 9.00 per labor hour)	- $ 0.15
Variable Overhead	(15 seconds of machine time @ $ 12.00 per machine hour)	- $ 0.05
Fixed Overhead	(per bracelet)	- $ 0.10
Total cost per bracelet		$ 0.38

During August, company records indicated the following actual cost and production information:

Purchases of Plastic:	48,000 ft. of plastic @ $ 0.11 per ft.
Usage of Plastic:	46,900 ft.
Direct Labor:	1,180 hours @ $ 9.05 per hour
Machine time:	288 hours
Variable Overhead:	$ 3,602
Fixed Overhead:	$ 7,650
Production:	70,260 bracelets

For Answer OF 469 F, Give 2 points

Required: Compute the following items and indicate your answers in the spaces provided. For each variance, indicate whether it is favorable (F) or unfavorable (U). Use the following page for your computations.

a) (3 Points) Budgeted Fixed Overhead for August $ 7,500

b) (3 Points) Direct Materials Price Variance $ 480 F

c) (3 Points) Direct Materials Efficiency Variance $ 7.20 U

d) (3 Points) Direct Labor Flexible Budget Variance $ 140 U

e) (3 Points) Variable Overhead Efficiency Variance $ 57 F

f) (3 Points) Total Fixed Overhead Over or Underapplication $ 624 Under.

g) (2 Points) Without necessarily computing it, just indicate whether the 1)

PART IV (18 Points)

The following data refers to the Daniels division of Tippett Inc. Daniels sells variable-speed drills. The drill sells for $ 40, and Daniels plans sales of 30,000 units in 1992. Tippett treats Daniels as an investment center with total attributable investment of $ 800,000. Daniels' annual fixed costs are $ 200,000. Variable cost per drill is $ 24. The firm's required rate of return on investment is 20%.

Assume that the division manager's goal is to maximize his Residual Income.
Ignore depreciation expense (i.e., assume that Cash flow = Accounting Income).

Answer each of the following parts independently, unless otherwise stated.

Required: 1. (2 points) What is the planned Return on Investment in 1992 ?

Income = 30K (40-24) − 200K = 280K

Investment = 800K

∴ ROI = $\frac{280K}{800K}$ = 35% — 2

2. (3 points) Daniels receives an external special order to buy 10,000 units at $ 30 each. If the order is accepted, Daniels will have to incur additional fixed costs of $ 40,000 and will have to invest an additional $ 145,000 in various assets.

What will be the net effect on Daniels' Residual Income of accepting the order ?

Incremental Income = Addl. CM (−) Addl. FC

= (30-24) × 10K (−) 40K = 20K.

Incremental Charge = (145K)(0.2) = 29K.

∴ Net effect on RI = 20K (−) 29K

= Loss of 9K.

3. (4 points) One of the components that Daniels manufactures for its product has a variable cost of $ 4. An outside supplier has offered to supply the 30,000 units required at a cost of $ 5 per unit. If the component is purchased outside, fixed costs will decline by $ 20,000 and assets with a book value of $ 45,000 will be sold at book value.

Will Daniels decide to make or buy the component ? Why ?

Relevant cost of buying: $(\$5 - \$4) \times 30K = \$\ 30{,}000$

Relevant benefit of buying: Reduction in FC = $ 20,000

Reduction in Imputed charge = $(45K)(0.2)$ = $ 9,000

$ 29,000

∴ Better to make component.

[If students compute that Make is better than Buy by $ 1,000 give full credit. Old Res Inc = 120k; New Res Inc = 119K.]

4. (3 points) Daniels is informed by a regular customer of its need for a particular type of drill. The customer will require 15,000 drills whose variable cost is estimated to be $ 12 per unit. Additional investment of $ 450,000 will have to be undertaken to produce the drills.

What is the minimum selling price that will make the deal acceptable to Daniels ?

Need z s.t

$$(z - 12) \times 15K = (450K)(0.2)$$

$$\Rightarrow \quad 15{,}000\, z = 270K$$

$$\Rightarrow \quad z = \$\ 18 \text{ per unit}$$

5. (6 points) Assume the same facts as in part 4. Assume also that the customer has offered to pay $ 22 for each drill. In addition, the customer has indicated that its purchases of the existing product will drop by 4,000 units.

(a) What would be the net change in Daniels' Residual Income from taking the offer, relative to its planned 1992 situation?

Additional CM = ($22 − $12)(15K) = $ 150,000

(Less) Lost CM = ($40 − $24)(4K) = $ 64,000

(Less) Imputed cost = (450K)(0.2) = $ 90,000

Net drop in RI = $ 4,000

(b) What is the drop in unit sales of the existing product which, if it were to occur, would leave Daniels indifferent to the offer ?

Find y s.t

150K + ($40 − $24)y + 90K = 0

⇒ 16y = 60,000

⇒ y = 3,750 units.

(IF THEY HAVE ANSWERS OF "INCREASE OF 20,000" AND "6,000 UNITS", GIVE 4 POINTS TOTAL.)

PART V (20 Points)

The Iron City Company, which started business on January 1, 1992, manufactures a single product. The company management experimented with the use of two costing systems: i) Variable, actual costing; and ii) Absorption, actual costing.
The following information is known for 1992:

	Actual Variable Costing	Actual Absorption Costing
Sales Revenue	$ 2,250,000	$ 2,250,000
Operating Profit	438,000	461,000
Actual Prime Costs Incurred	1,280,000	1,280,000
Fixed Marketing Costs	295,000	295,000
Number of Units Sold	180,000	180,000
Ending Finished Goods Inventory (value per unit)	$ 7.15	$ 8.30

There were no beginning inventories and no ending Work-in-Process Inventory for 1992.
There is an ending Finished Goods inventory on December 31, 1992.
There are no variable non-manufacturing expenses, but there does exist variable overhead.
Required: 1. (3 points) What is the contribution margin generated in 1992 ?

No opening inventory ⇒
Unit cost of ending invy = Unit cost of goods sold.
∴ Var COGS = (180 K)($ 7.15) = $ 1,287,000
∴ CM = 2,250,000 (-) 1,287,000
= 963,000

2. (4 points) Assume that the fixed costs of the firm included fixed marketing and fixed manufacturing costs. What are the total fixed manufacturing costs incurred ?

CM (-) Total FC = Var op profit
963 K (-) Total FC = 438 K
⇒ Total FC = 525 K
∴ Total Mfg fixed costs = 525 K (-) 295 K (Fix Mktg)
= $ 230,000

3. **(5 points)** Show that the firm produced a total of 200,000 units in 1988.

Unit FC = 8.30 − 7.15 = $1.15

Total Fixed Mfg costs = $230,000

∴ Units produced = $\frac{230\,K}{1.15}$ = 200,000

4. **(4 points)** What is the actual total variable overhead incurred?

Total Var Mfg costs incurred

= (200 K)($7.15) = $1,430,000.

(−) Total prime costs = 1,280,000

= VOH incurred 150,000

5. **(4 points)** How much total overhead is expensed on the income statement under the Actual variable costing method, either through COGS or as a period expense?

FOH fully expensed = 230,000

VOH expensed as COGS

= (150,000)$\left(\frac{180,000}{200,000}\right)$ = 135,000

$ 365,000

PART VI (17 points)

Division A produces a component part which can be sold either to outside customers or to Division B. Selected operating data on the two divisions are given below:

Division A:	Unit selling price to outsiders	- $ 75
	Unit variable production cost	- $ 45
	Unit variable selling cost	- $ 2
	Total fixed production cost	- $ 300,000
	Capacity	- 20,000 units per year.
Division B:	Outside purchase price per unit	- $ 72

Division B has always purchased its component parts from outside suppliers, but is now considering the purchase of parts from division A. A study has determined that the variable selling expenses of division A would be cut in half for any sales to division B. All divisions are treated as autonomous entities.

Required: For parts 1-3, assume that A has ample capacity to handle B's needs.

1. (2 points) What is the maximum transfer price that can be justified between the divisions (i.e., the maximum transfer price which ensures that a transfer takes place) ?

$ 72 2

2. (2 points) What is the minimum transfer price that can be justified between the divisions ?

$ 46 2

3. (5 points) Suppose that the firm mandates A to make the units required by B out of its excess capacity and to transfer them to B at a price of $ 80 per unit. If B is forced to pay this price and purchase from A (instead of from its external suppliers), what will be the impact on firm profits ? Give the answer on a per-unit basis.

TP paid to A by B =	$ 80
(less) A VC =	$ 46
A CM/unit	$ 34
(less) Decrease in B CM/unit (80-72)	8
Net firm increase in CM/unit	$ 26

LAST NAME: _____ 12

4. (3 points) Assume that A can sell its entire capacity to outsiders.
What is the minimum internal transfer price that A will find acceptable ?

VC = $ 46

(+) Opp cost = $ 28 [75 − (45 + 2)]

74

FOR ANSWER OF 75, GIVE 1 POINT

$ 74

5. (5 points) Suppose that A can sell its entire capacity to outsiders. Suppose that the firm mandates A to make the units required by B and to transfer them to B at a price of $ 80 per unit. If B is forced to pay this price and purchase from A (instead of from its external suppliers), what will be the impact on firm profits ? Give the answer on a per-unit basis.

A: Old CM = 75 − (45 + 2) = $ 28

New CM = 80 − (45 + 1) = $ 34

∴ Gain = $ 6 per unit

B: Lost CM per unit = 80 − 72 = $ 8

∴ Net loss = $ 2 per unit.